NASA CR-132372 - Volume II

ANALYTICAL STUDY TO DEFINE A

HELICOPTER STABILITY DERIVATIVE

EXTRACTION METHOD

VOLUME II - FINAL REPORT (DATA VOLUME)

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UNITED AIRCRAFT CORPORATION
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and

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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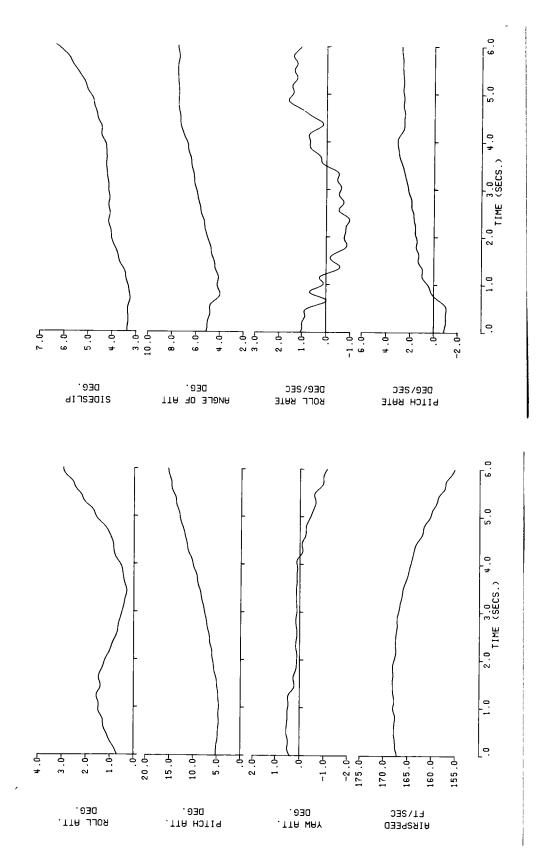
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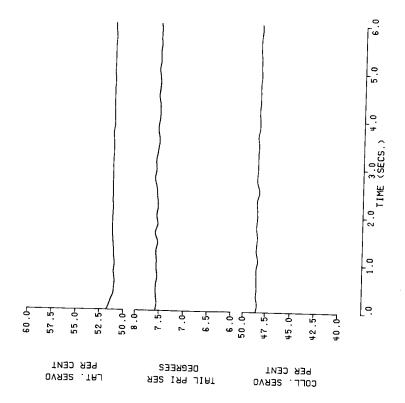
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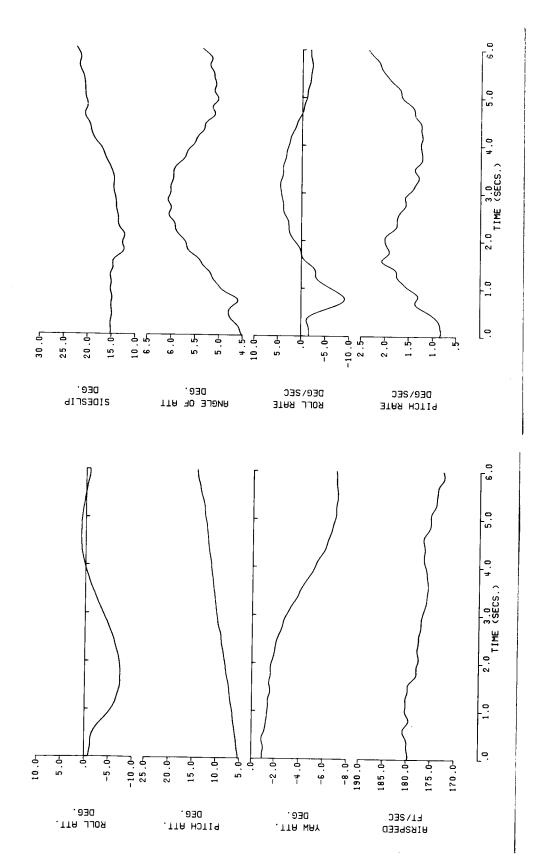
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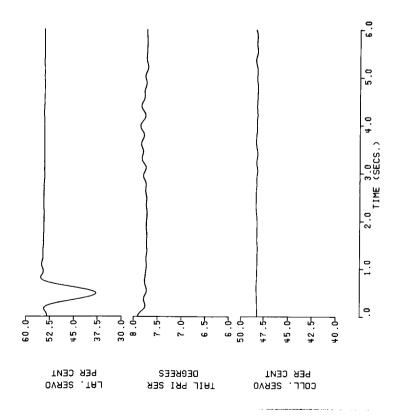


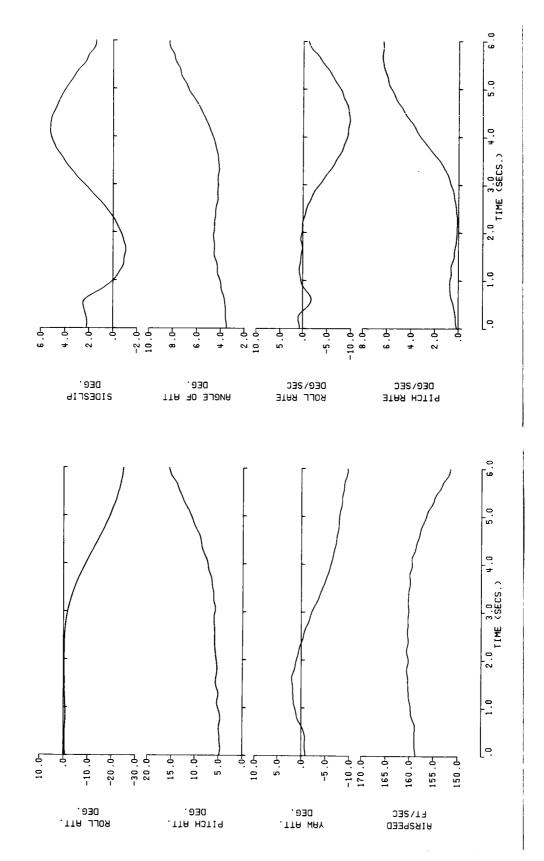


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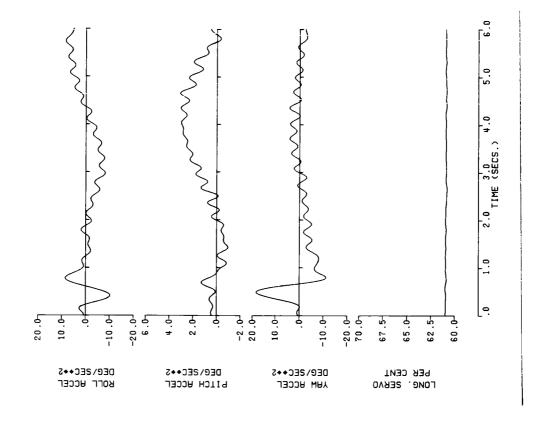
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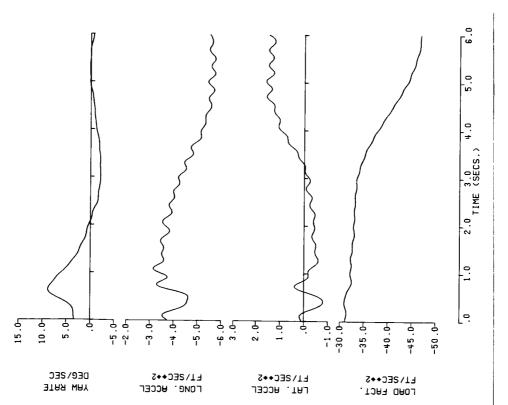
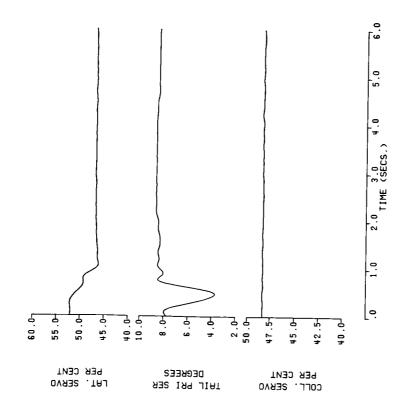


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Flight Test Data Filtered At 3 HZ.

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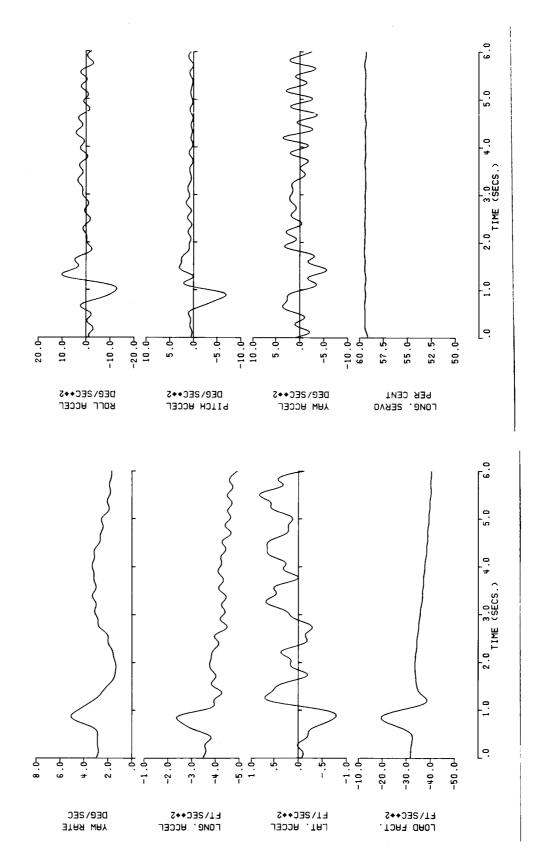
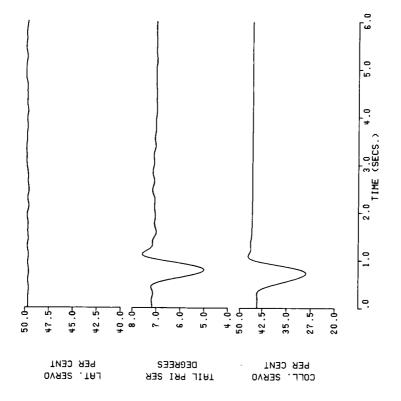
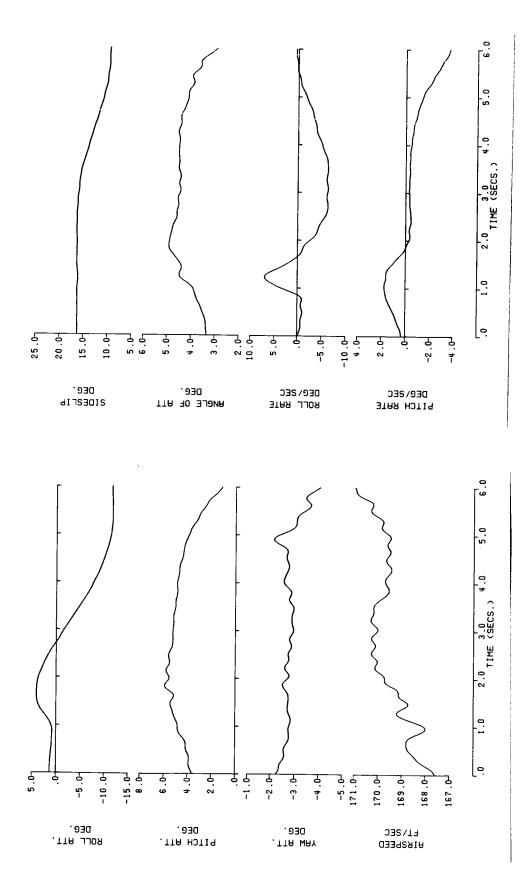


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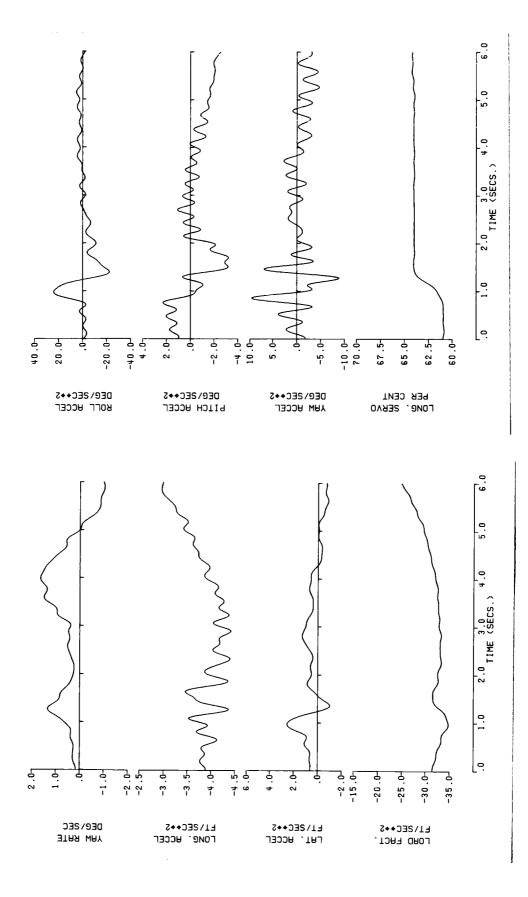


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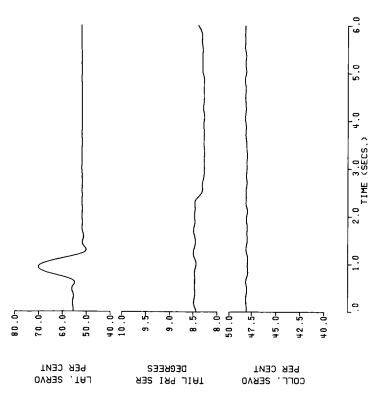
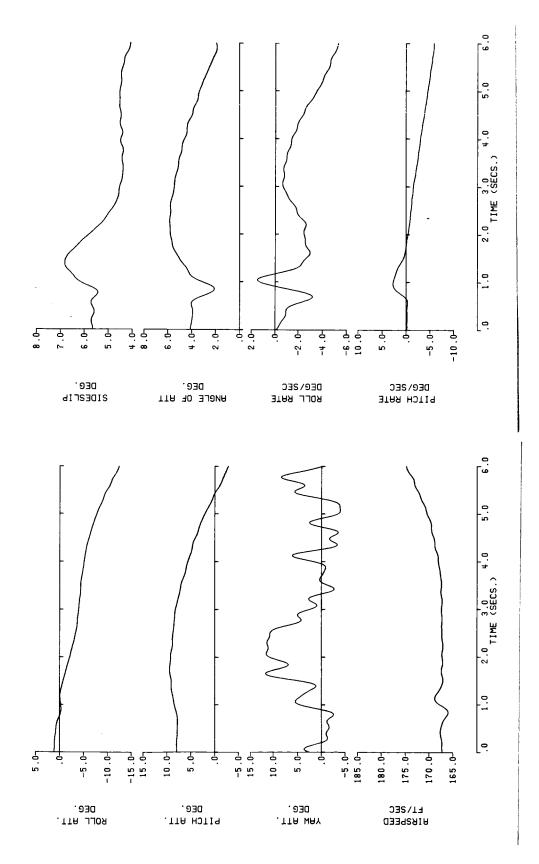


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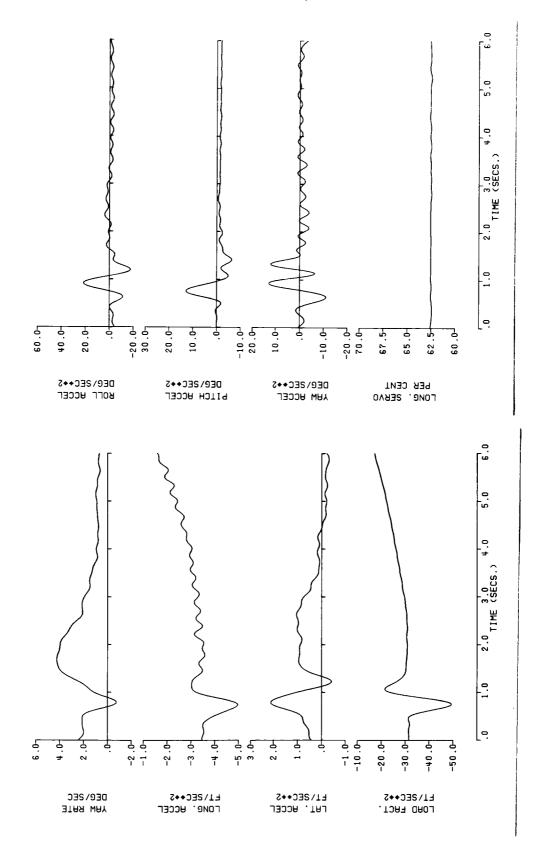
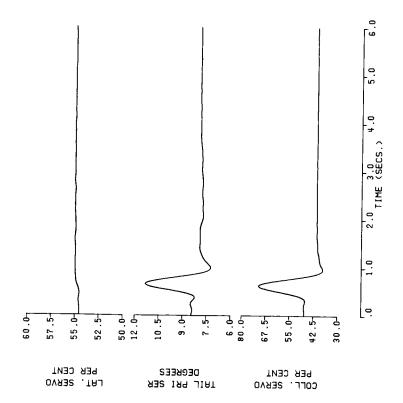
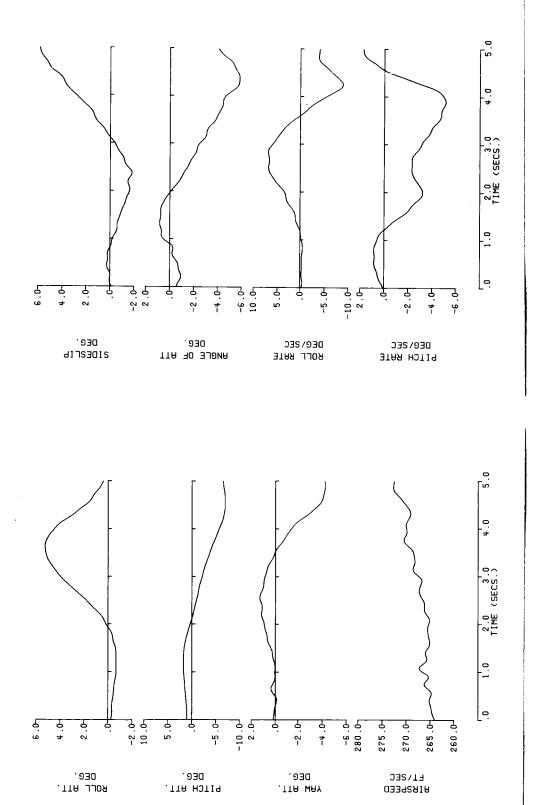


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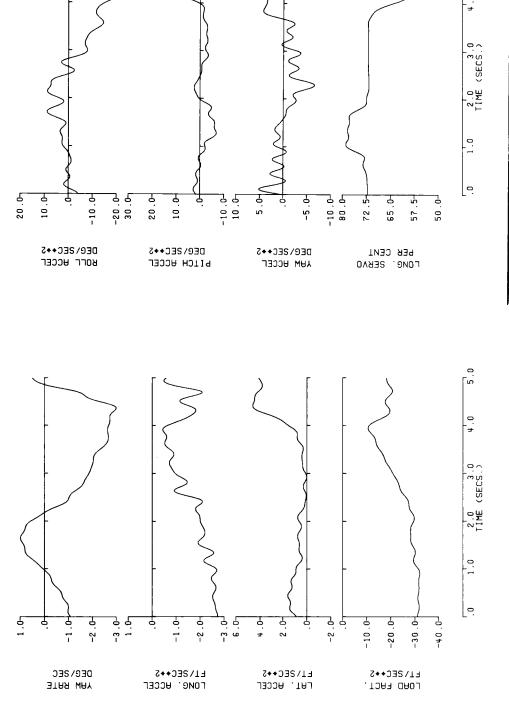


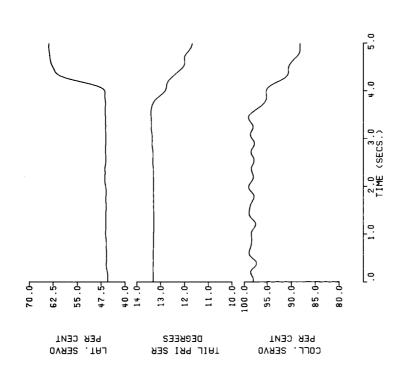
Flight Test Data From CH-53A Filtered With A Digital Filter At 3 HZ. (150 knots, Maneuver 1). ı Ŀ Figure

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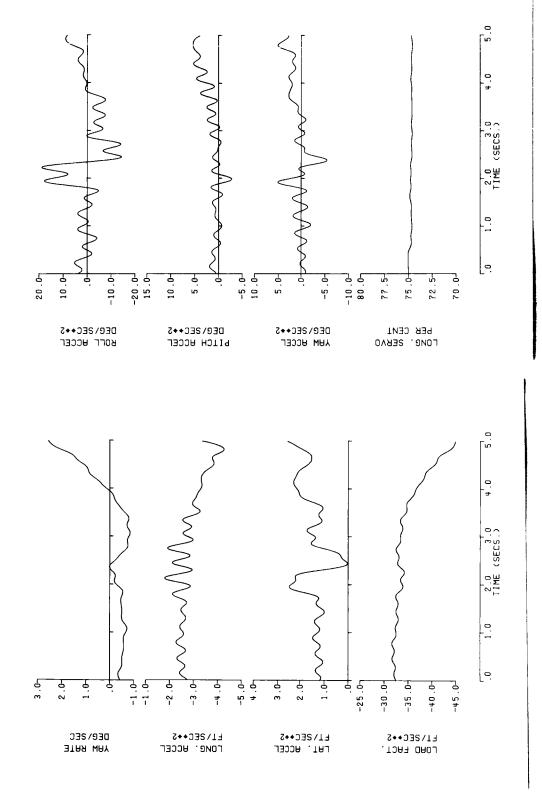
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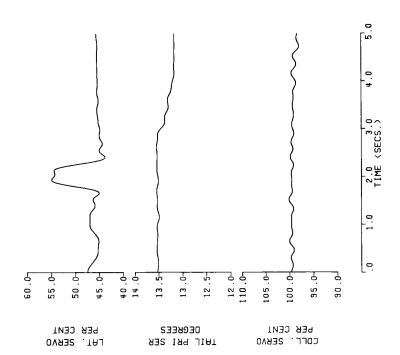
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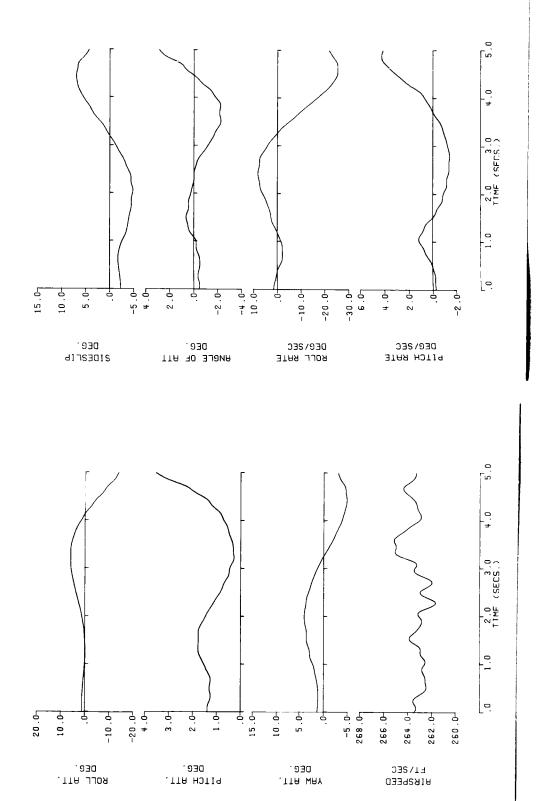
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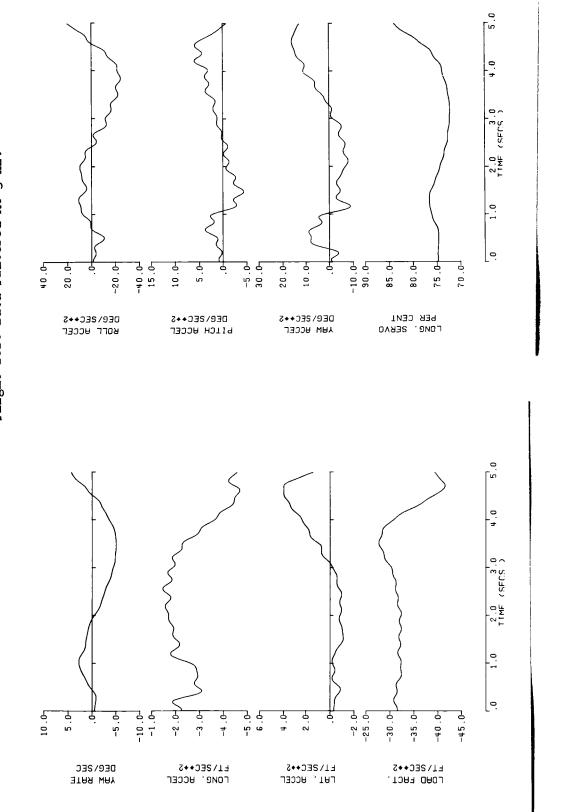
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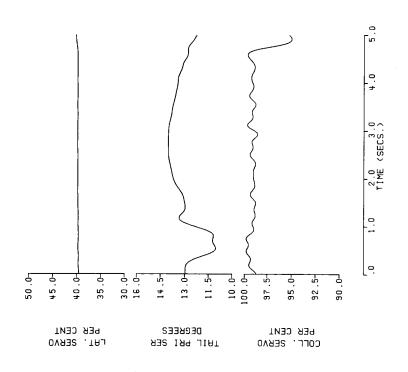


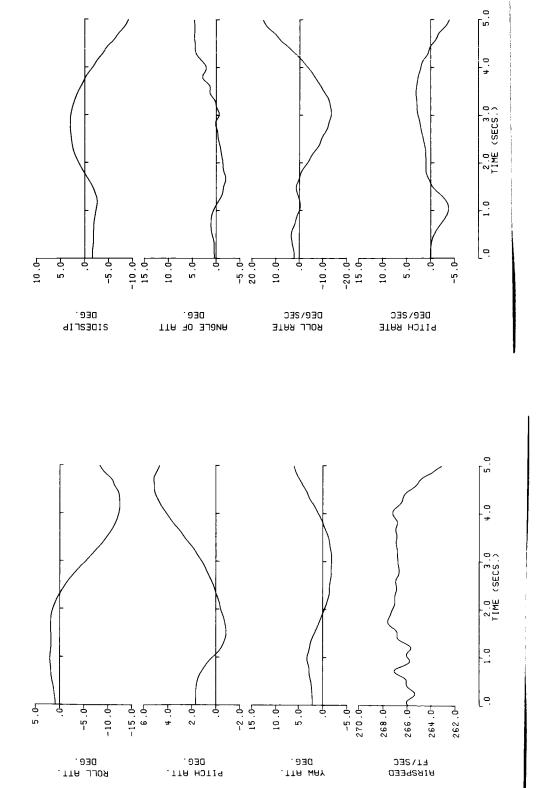


Flight Test Data From CH-53A Filtered With A Digital Filter At 3 HZ. (150 knots, Maneuver 3). 1 o, Figure

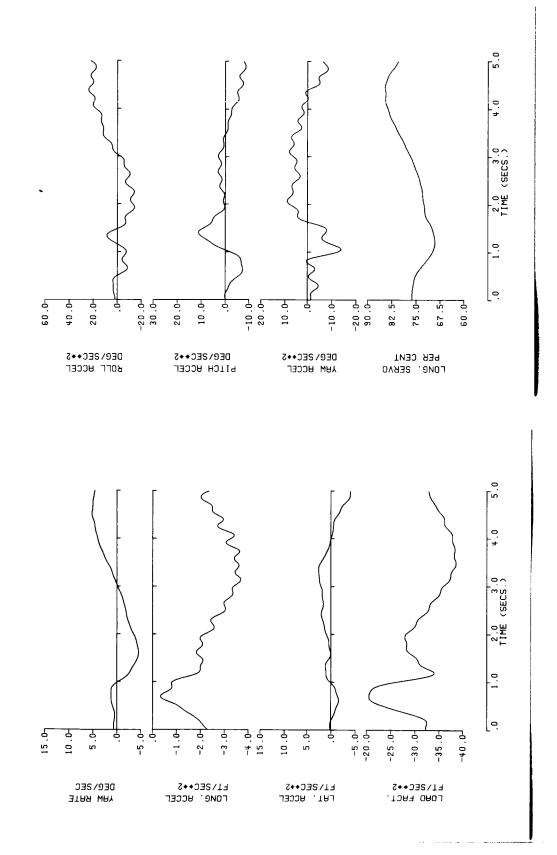


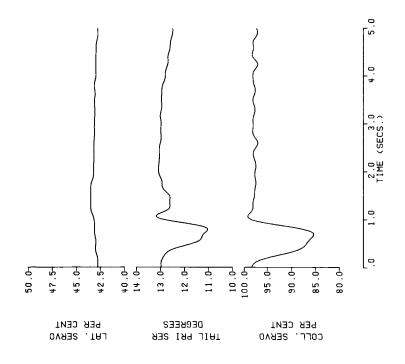


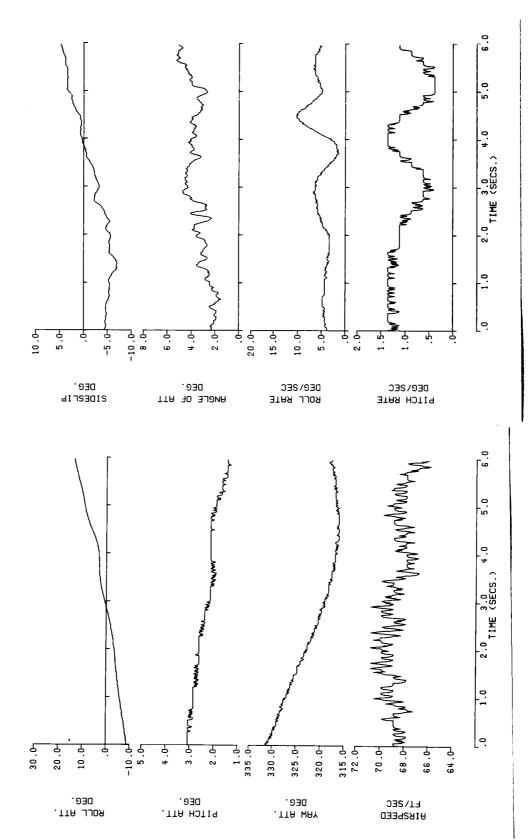




Flight Test Data From CH-53A Filtered With A Digital Filter At 3 HZ. (150 knots, Maneuver μ). ı 97 Figure

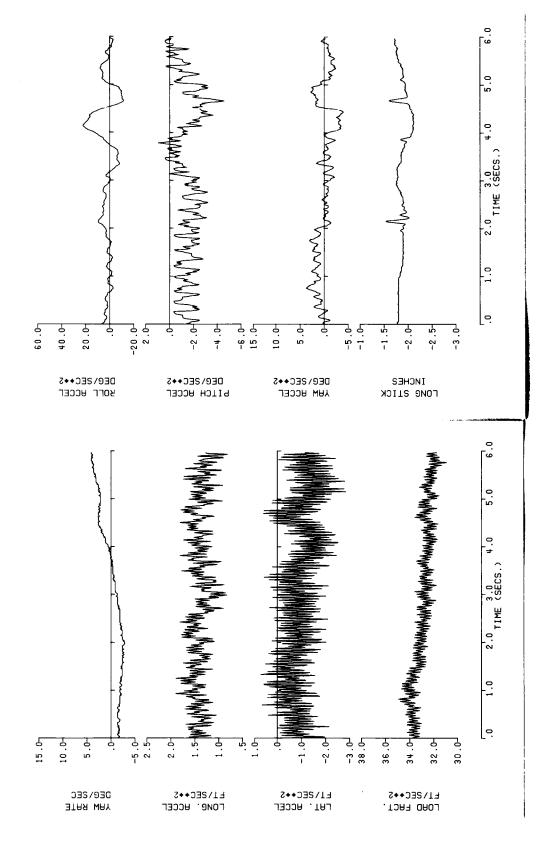




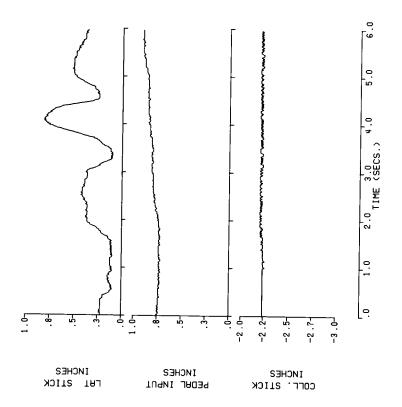


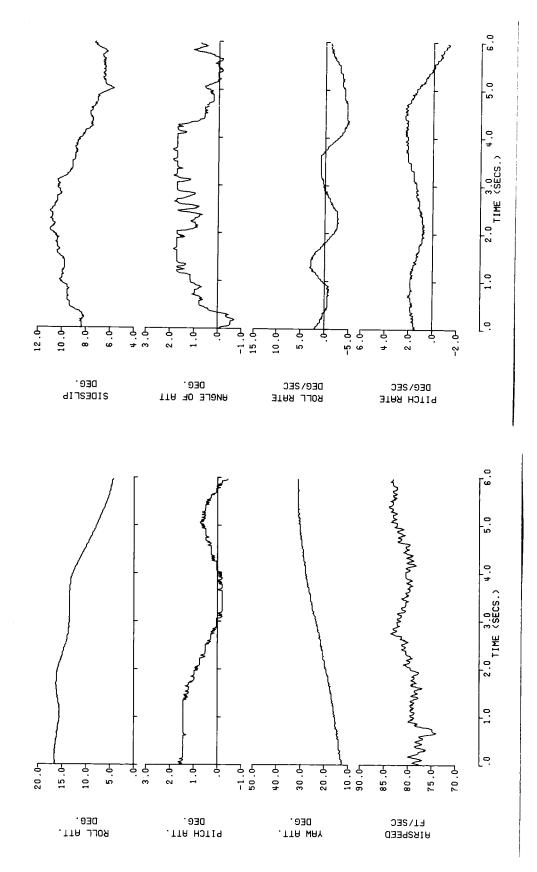
Flight Test Data From CH-54B Filtered With a First Order Low Pass Filter at 8 HZ. (45 knots, Maneuver 1) ı 1

Figure









Flight Test Data From CH-54B Filtered With a First Order Low Pass Filter at 8 HZ. (45 knots, Maneuver 2) ı 12 Figure

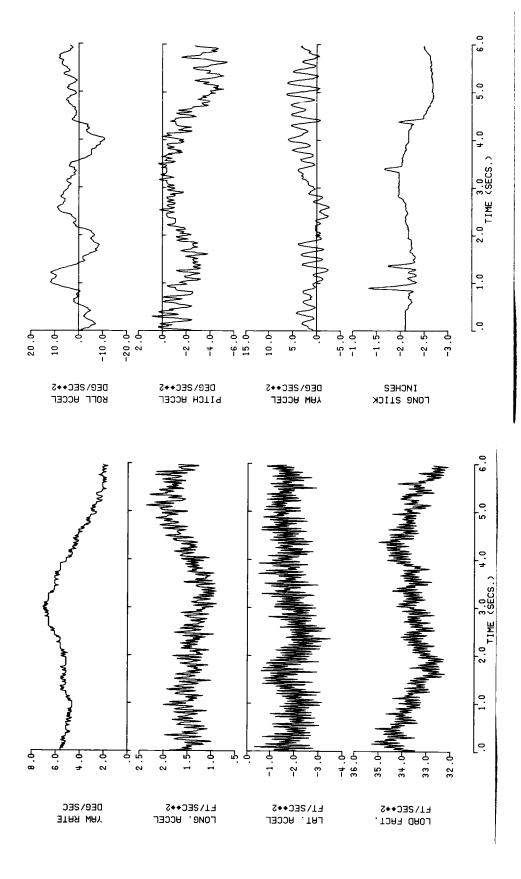
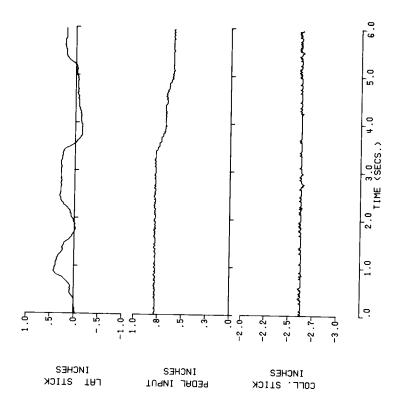
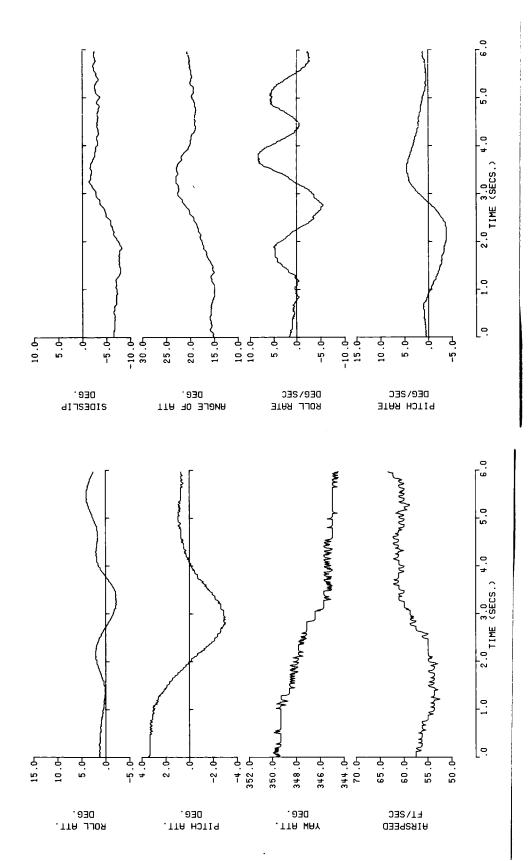


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Flight Test Data From CH-54B Filtered With A First Order Low Pass Filter at 8 HZ. (45 knots, Maneuver 3). 1 Figure 13.

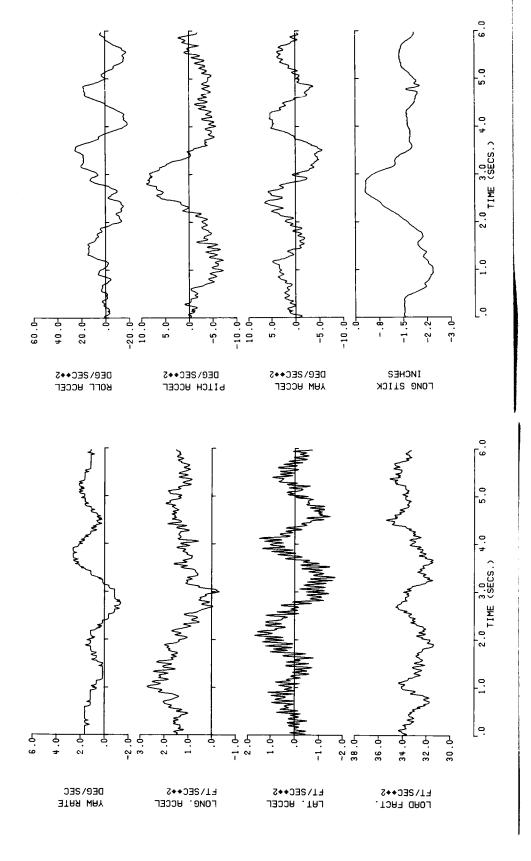
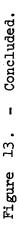
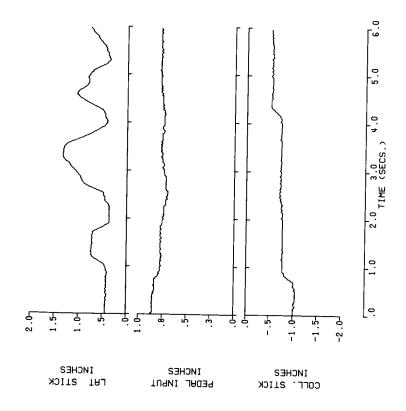
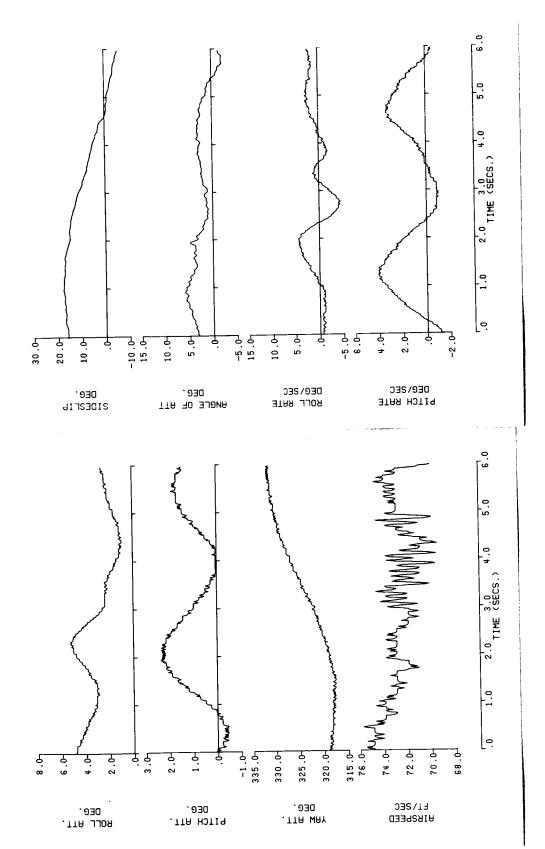


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Flight Test Data From CH-54B Filtered With A First Order Low Pass Filter at 8 HZ. (45 knots, Maneuver 4). Figure 1^{μ} .

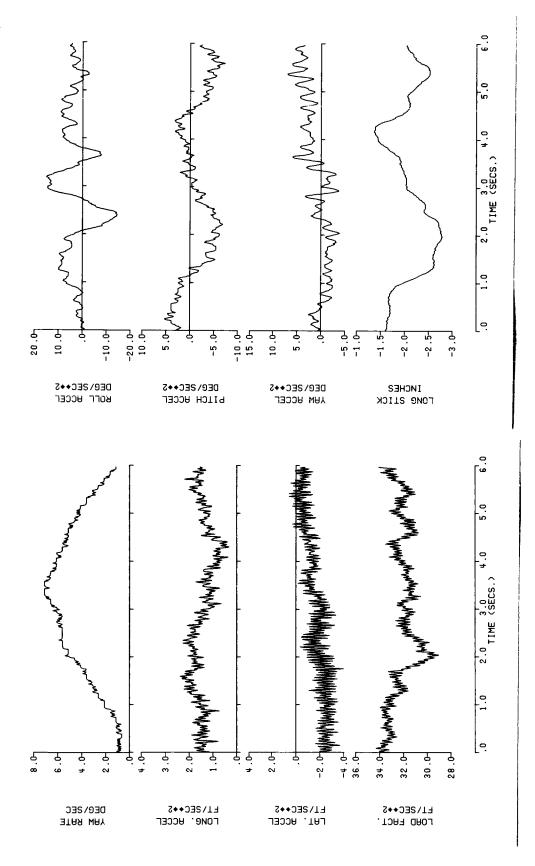
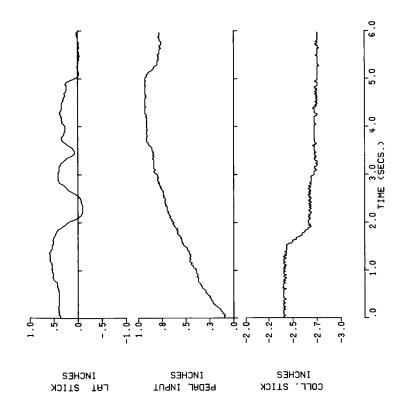
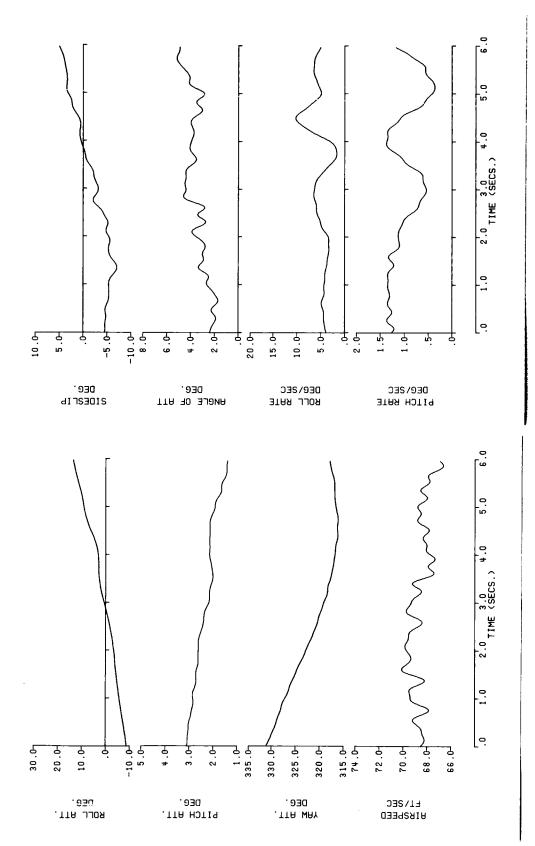


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Flight Test Data From CH-54B Filtered With A Digital Filter At 3 HZ. (45 knots, Maneuver 1). Figure 15.

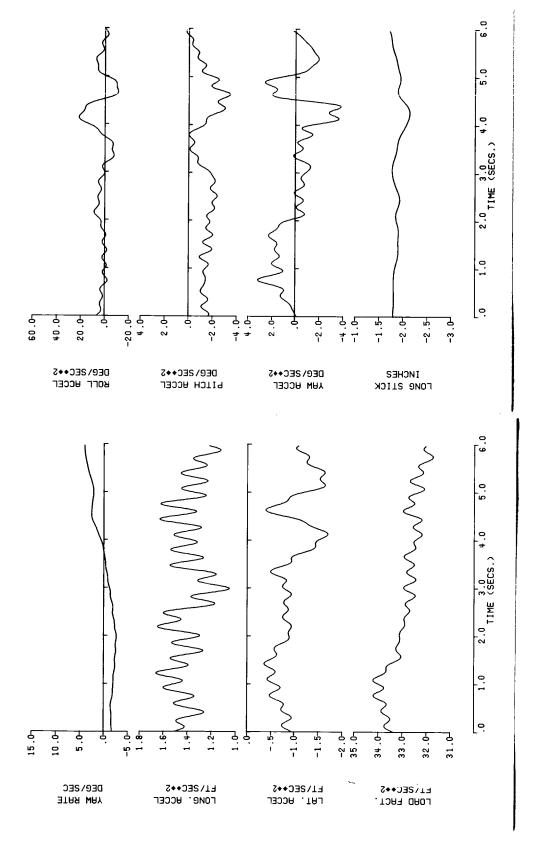
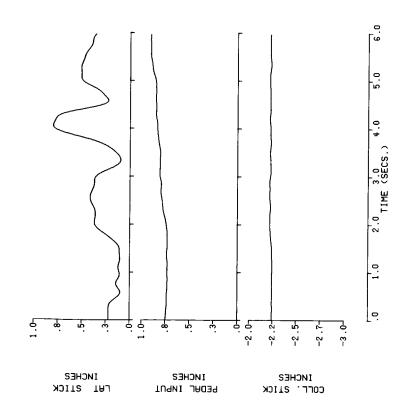
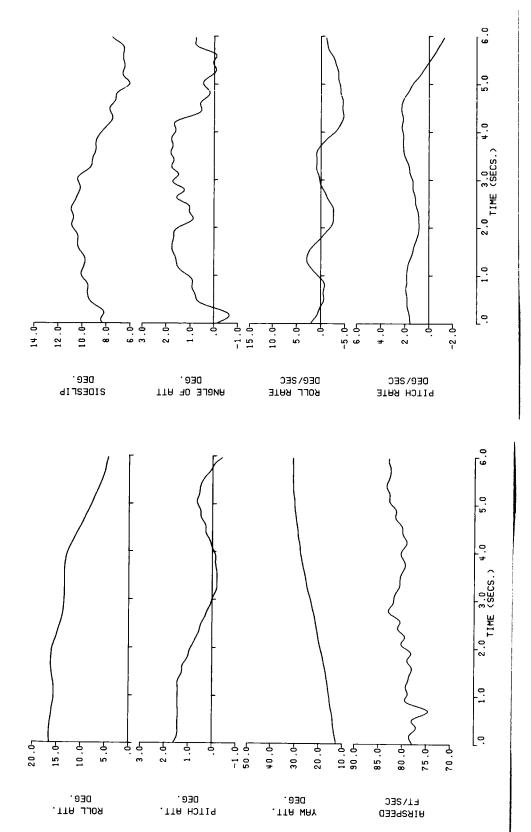


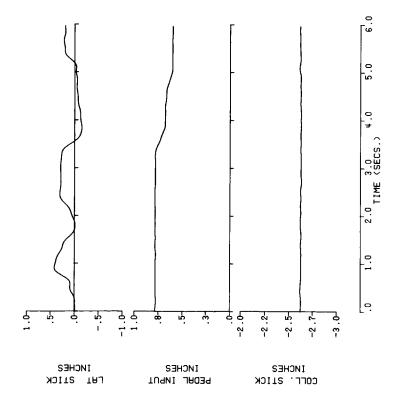
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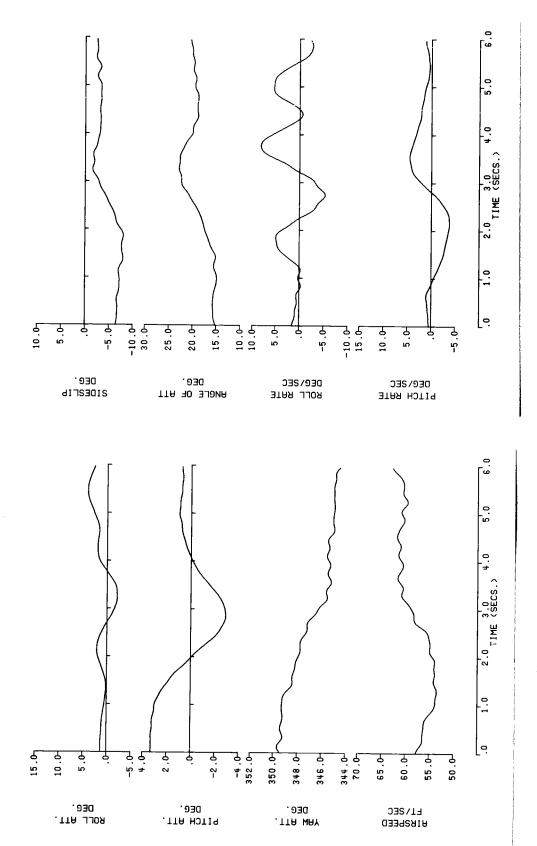




Flight Test Data From CH-54B Filtered With A Digital Filter At 3 HZ. (45 knots, Maneuver 2). Figure 16

Figure 16. - Continued.





Flight Test Data From CH-54B Filtered With A Digital Filter At 3 HZ. (45 knots, Maneuver 3). 1 Figure 17.

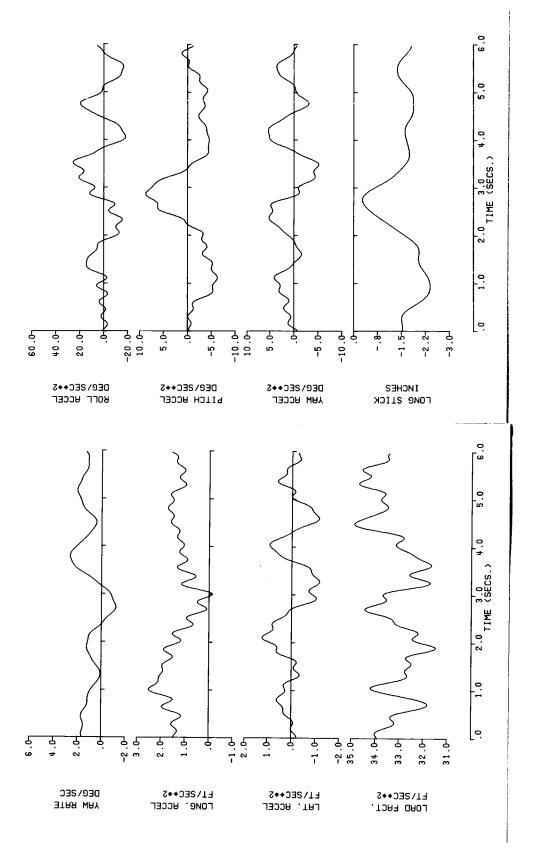
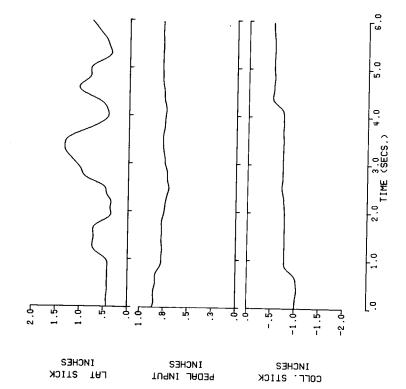
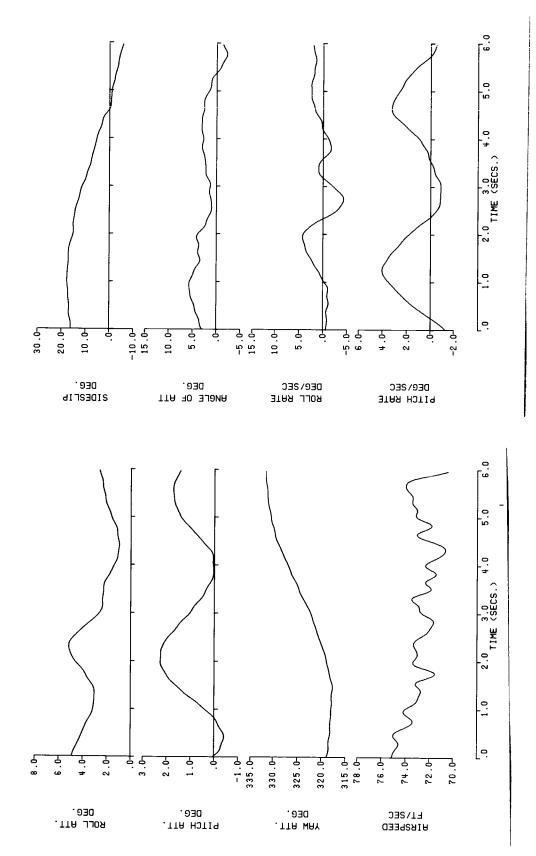


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Flight Test Data From CH-54B Filtered With A Digital Filter At 3 HZ. (45 knots, Maneuver 4). ı Figure 18.

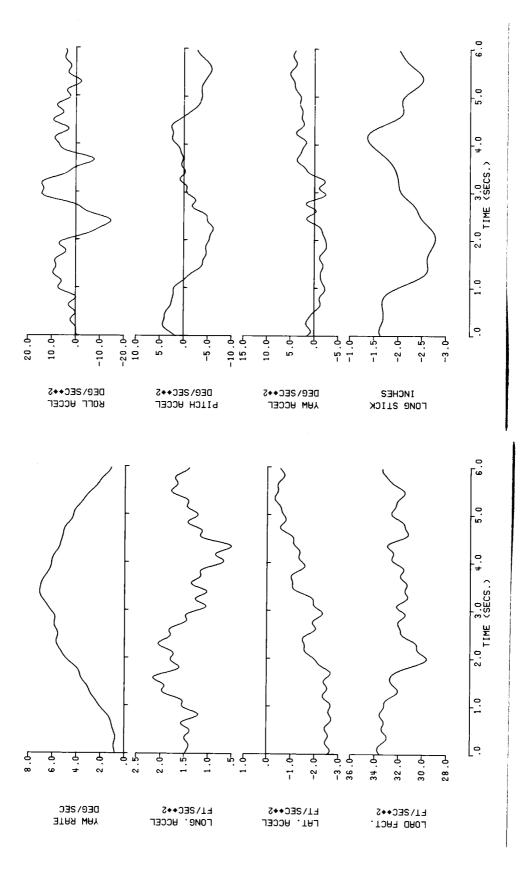
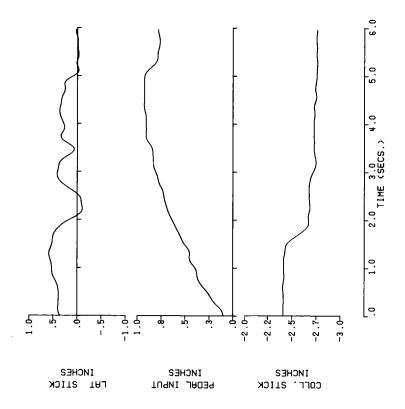
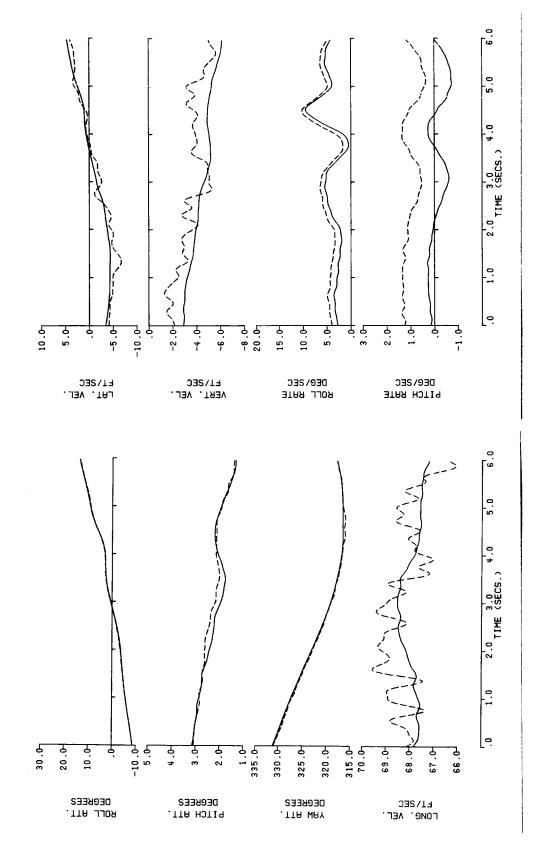


Figure 18. - Continued.



------ Kalman Filtered Flight Data ----- Digital Filtered Flight Data at 3 HZ.



Comparison of Flight Test Data From CH-5 $^{\rm th}$ B Using the Kalman and Digital Filtering Methods (45 knots, Maneuver 1). ı Figure 19.

----- Kalman Filtered Flight Data ---- Digital Filtered Flight Data at 3 HZ.

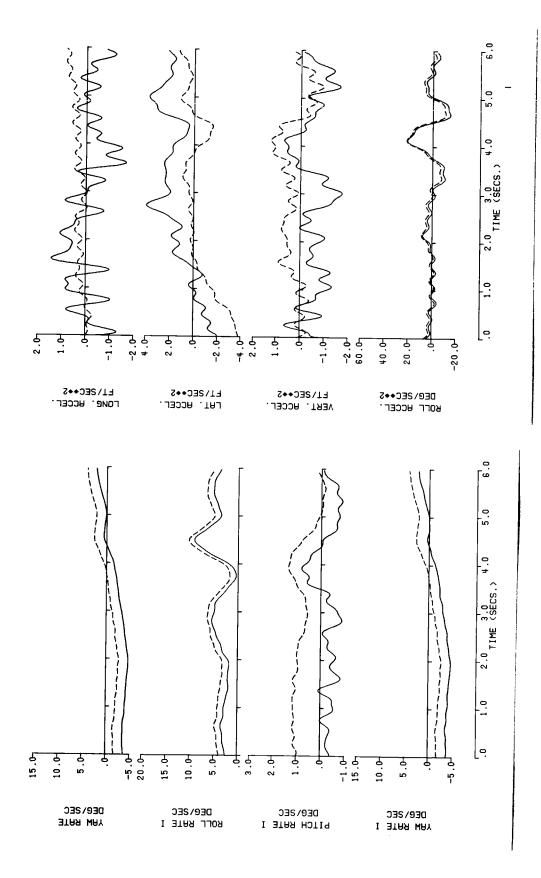


Figure 19. - Continued.

----- Kalman Filtered Flight Data ----- Digital Filtered Flight Data at 3 HZ.

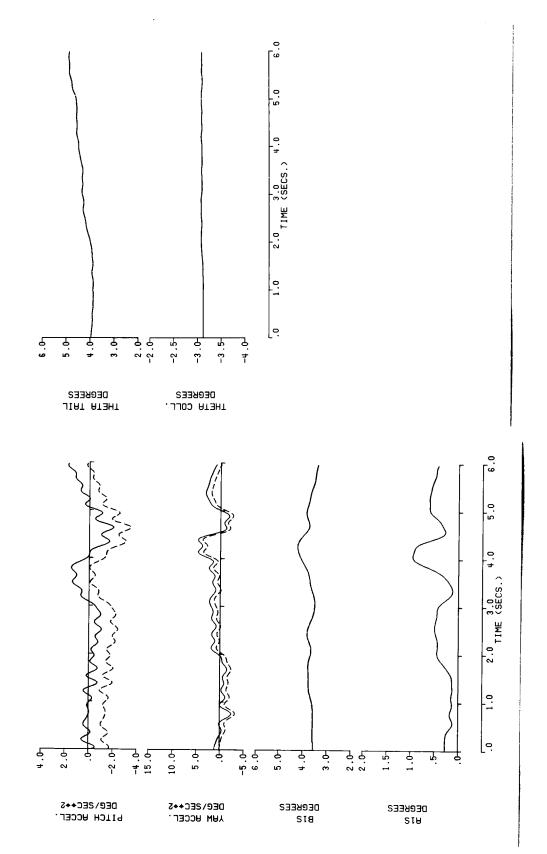
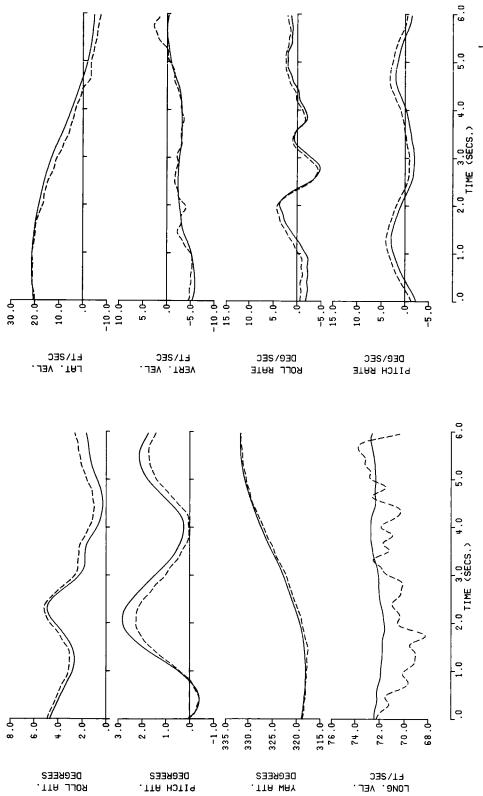


Figure 19. - Concluded.

Digital Filtered Flight Data at 3 HZ. Kalman Filtered Flight Data 30.05 10.01 20.01 LAT. VEL. FT/SEC



Comparison of Flight Test Data From CH-54B Using the Kalman and Digital Filtering Methods (45 knots, Maneuver 4). 1 Figure 20.

----- Kalman Filtered Flight Data ----- Digital Filtered Flight Data at 3 HZ.

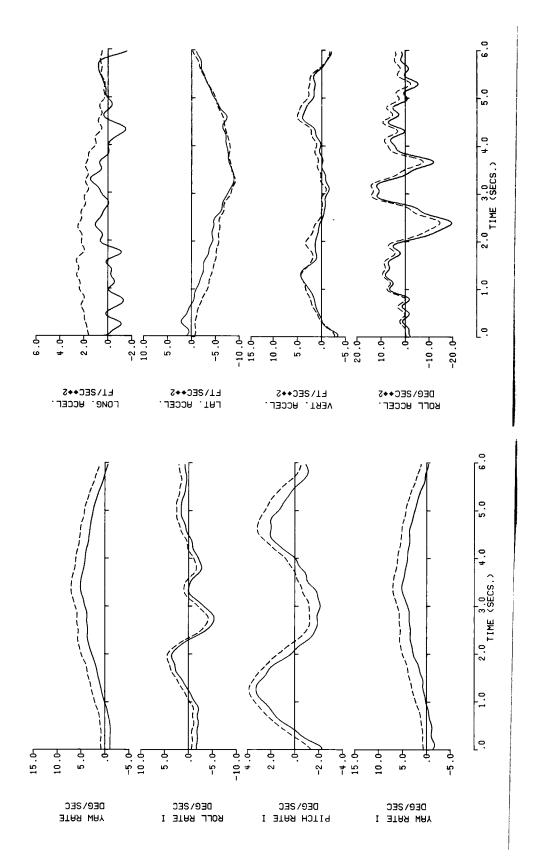


Figure 20. - Continued.

----- Kalman Filtered Flight Data ----- Digital Filtered Flight Data at 3 HZ.

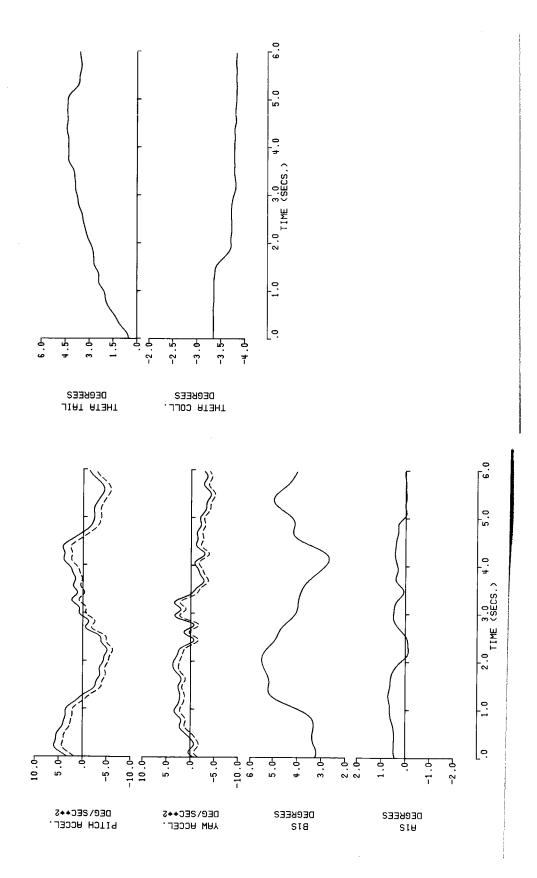
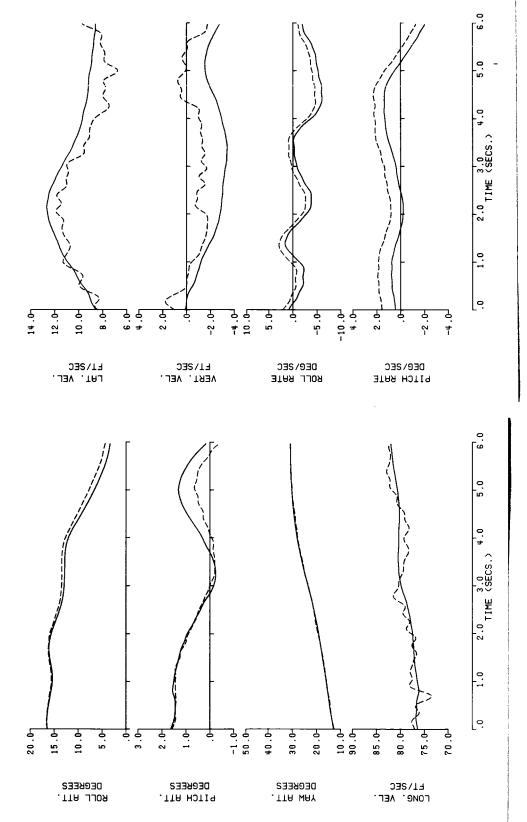


Figure 20. - Concluded.

----- Kalman Filtered Flight Data ----- Digital Filtered Flight Data at 3 HZ.



Comparison of Flight Test Data From CH-54B Using the Kalman and Digital Filtering Methods (45 knots, Maneuver 2). ı ۲<u>.</u>

Figure

----- Kalman Filtered Flight Data

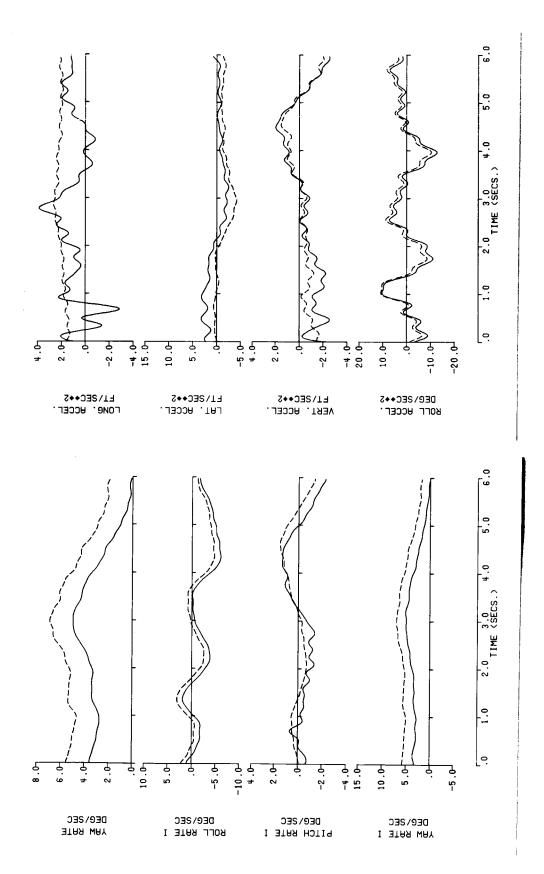


Figure 21. - Continued.

----- Kalman Filtered Flight Data ---- Digital Filtered Flight Data at 3 HZ.

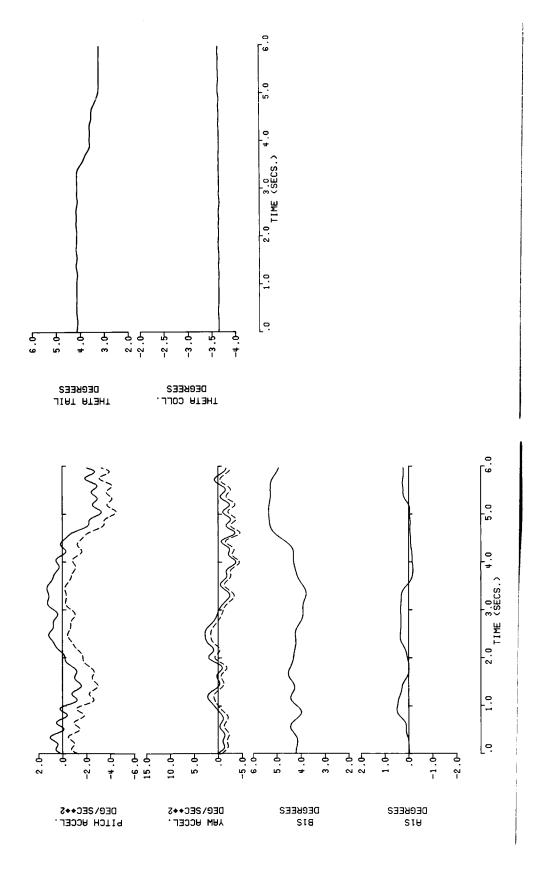


Figure 21. - Concluded.

ص 0. . .÷ 2'.0 3'.0 TIME (SECS.) Digital Filtered Flight Data at 3 HZ. Kalman Filtered Flight Data 0 년. 7 **8**.9 -5.0 -10.0 لا 10.0[–] 10.0 -10.0⁻ 0.9 -15.0 -20.04 ۍ ٩ J. 7 10.P 5.0 -5.0 LAT. VEL. FI/SEC VERT. VEL. FT/SEC BOLL RATE PITCH RATE DEG/SEC 9.0 5.0 2.0 3.0 TIME (SECS.) 15.0ţ, -4.0√ 352.07 10.01 م. 350.04 348.0 344.07 70.07 Ġ ġ ار م 346.0⊢ 65.0 50.07 55.0 P. 09 LONG. VEL. FT/SEC DECKEES DECKEES DEGREES . אסבר אוד. TIA HOTI9 .TIA WAY

Comparison of Flight Test Data From CH-54B Using the Kalman and Digital Filtering Methods (45 knots, Maneuver 3). ı 25 **.** Figure

6.0

----- Kalman Filtered Flight Data ---- Digital Filtered Flight Data at 3 HZ.

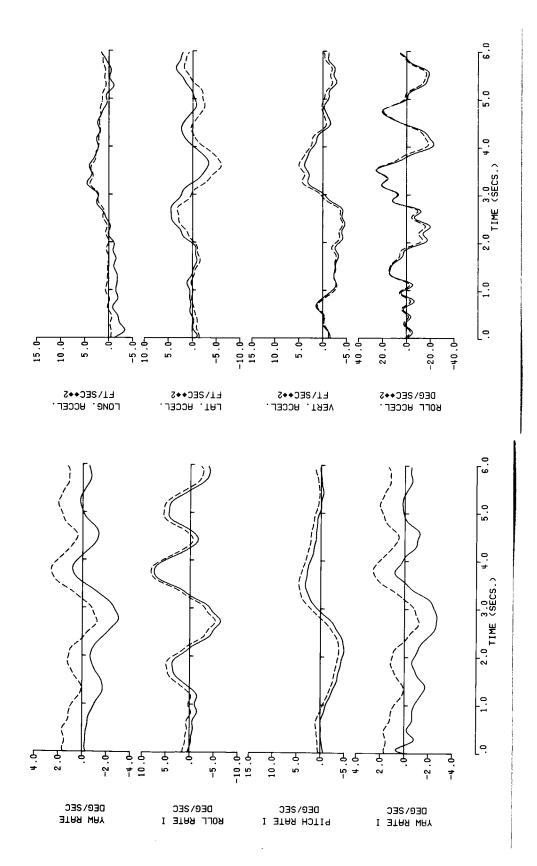


Figure 22 - Continued.

----- Kalman Filtered Flight Data ----- Digital Filtered Flight Data at 3 HZ.

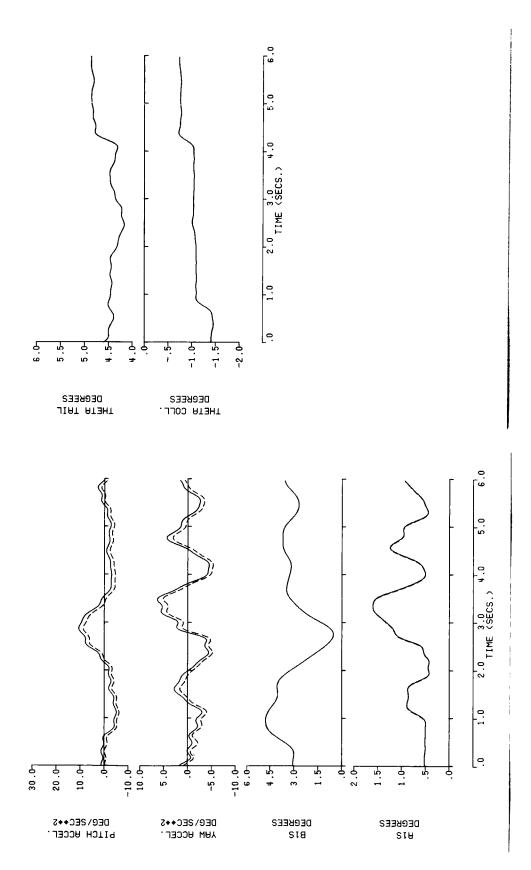
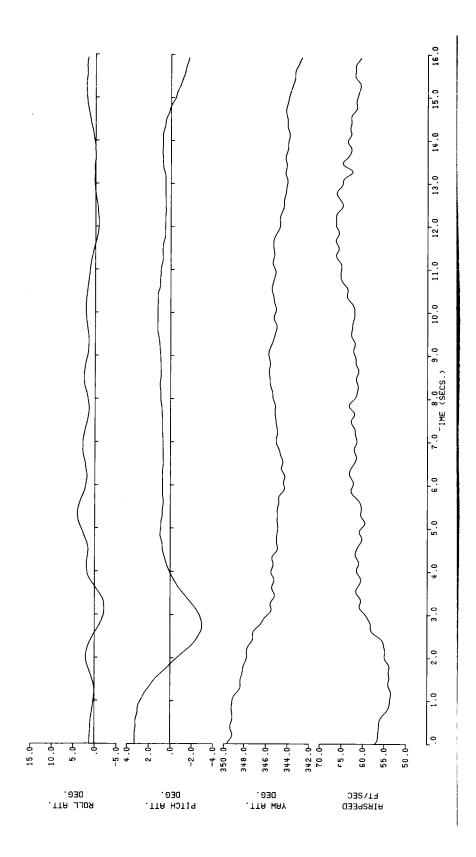
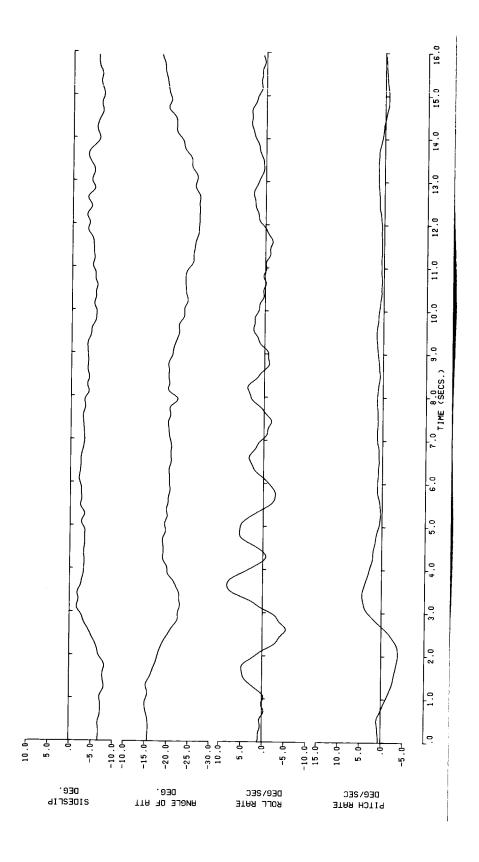


Figure 22. - Concluded.



Flight Test Data From CH-54B Filtered With a Digital Filter at 3 HZ. (45 knots, 16 sec. Maneuver). ı Figure 23.



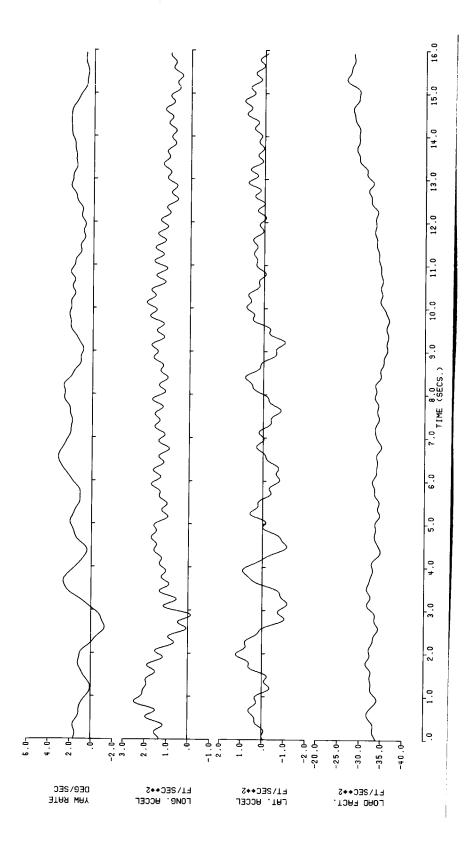


Figure 23. - Continued.

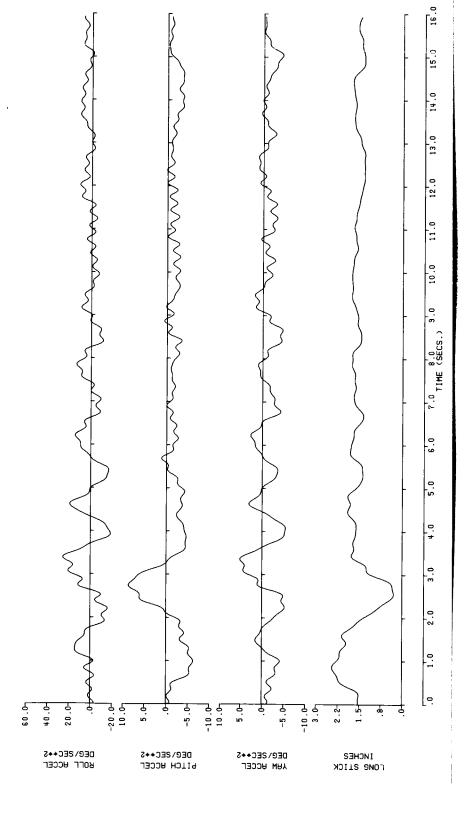
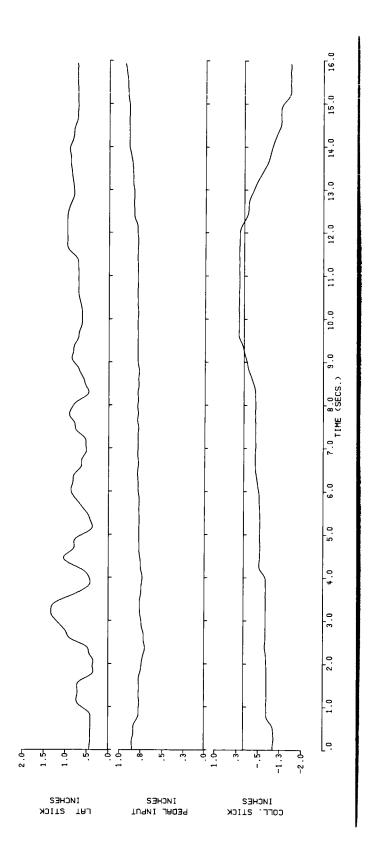


Figure 23. - Continued.



ر به 0 5. Max. Likelihood Derivative Model (Method 7) Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data [0 0.08 #0.0# 20.0-30.05 60.04 25.0-20.0-15.0 لن. 10 لو. 6 <u>1</u> -2.0-15.0-10.0--5.0ġ LAT. VEL. FT/SEC VERT, VEL. FT/SEC BEG/SEC DEC\ SEC PITCH RATE 0.9 • • • • • • • • 0 r. -<u>-</u>-.0 3'.0 TIME (SECS.) ۳. 1.0 0. -2.01 6.9 ₽. 2 P. 9 30.0+ 20.07 10.01 ج ج دَ -10.01 -15.0⁻170.0₇1 160.0-130.04 ġ. -5.0-150 . PH ROLL ATT. DEGREES LONG. VEL. F1/SEC DEGREES PITCH ATI. .IIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 1). ı 54. Figure

Max. Likelihood Derivative Model (Method 7) Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 0. [<u>-</u> لن 10. ما--5.0⁻¹ 5.0 -10.01 –15.0[–] 15.0 10.0T -5.0-15.0-10.0I 5.P VERI. ACCEL. FI/SEC++2 DEG/SEC++5 LONG. ACCEL LAT. ACCEL. FT/SEC++2 و. 0. [e 2.0 ال-2.0 15.0 5.0

DEG/SEC

BOLL RATE I

DE@/8EC YAW RATE VAW RATE I

Continued. 5 7 7 Figure

5.0

, 1

Kalman Filtered Flight Data Least Square Derivative Model (Method 1) Max. Likelihood Derivative Model (Method 7)

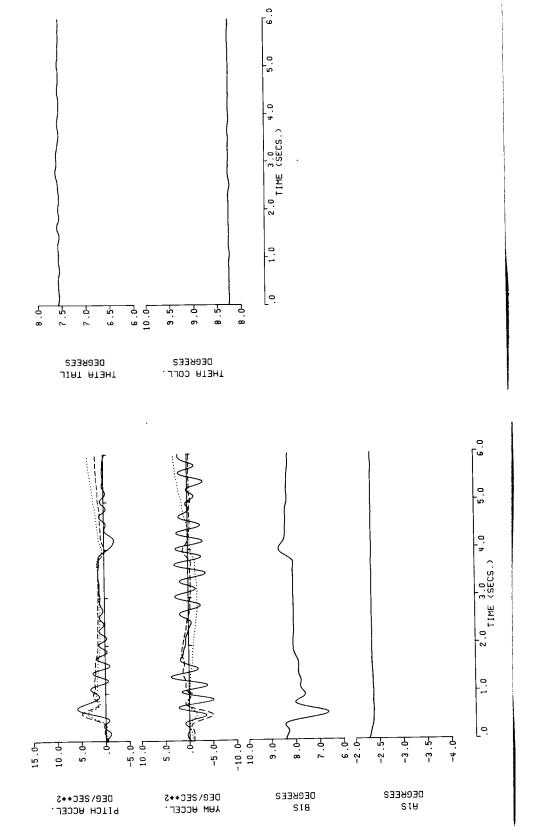


Figure 2^{μ} . - Concluded.

5.0 Max. Likelihood Derivative Model (Method 7) 0. Least Square Derivative Model (Method 1) 2.0 3.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 <u>.</u> 20.02 10.0 20.07 10.01 -20.02-6.07 <u>+</u> 2.0-₽. 50.07 15.0 150.0-100.0-PITCH RATE DEG/SEC VERT. VEL. FT/SEC DEG/SEC ROLL RATE LAT. VEL. FI/SEC 9.0 • 5.0 0. 2'.0 3'.0 TIME (SECS.) 1.0 [--10.01-190.091 180.0-160.0- 150.0^{-1} لى 10.0-20.03 5.9 30.05 20.05 10.01 15.0 10.01 ٦٥.01 5.0 170.0ġ Ÿ 2 YAW ATT. DEGREES LONG. VEL. FT/SEC PITCH ATT. DEGREES ROLL ATT. DEGREES

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 2). ı S S Figure

9.0 5.0 Max. Likelihood Derivative Model (Method 7) Kalman Filtered Flight Data Least Square Derivative Model (Method 1) 2'0 3'0 TIME (SECS.) .. [o 10.01 -5.0 L0.01-_10 .01-_10 .01 15.P 20.04 10.01 20.04 LONG, ACCEL. LAT. ACCEL. FT/SEC++2 VERT, ACCEL. FT/SEC++2 BEG/SEC++5 0. 9 5.0 . --2.0 3.0 TIME (SECS.) 1.0 [0. ٠. و. -10.01-20.05 10.01 -10.04 -10.01-BEG/SEC BOLL RATE I PITCH RATE I DEG/SEC YAW RATE I DEC/2EC

YAW RATE

Continued. ı 25. Figure

0. و 5.0 Max. Likelihood Derivative Model (Method 7) . . Kalman Filtered Flight Data Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) 1.0 6 10.01 9.5 **8**.0 6.0 9. 9 THETA TAIL 0EGREES тнета сосс. Вевкееs . 0.9 5.0 0. 2.0 3.0 TIME (SECS.) 1.0 **8**.0 <u>Ŧ</u> -2.0-10.01 5. P -10.01 10.01 <u>ه</u> ۲ -1.0 구. 2-PITCH ACCEL. DEGKEES UIS DEG/SEC++5 DECKEES ទរខ

Figure 25. - Concluded.

ا 9.0 5.0 Least Square Derivative Model (Method 1)
Max. Likelihood Derivative Model (Method 7) 0 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 <u>.</u> و 50.0 -50.01 -6.0+ 30.0 20.05 ; 6. 유. -30.05 10.01 -10.01 15.0-10.P 5. P 100.0 -20.0- LAT. VEL. FI/SEC VERT. VEL. FT/SEC 0E6/SEC 80LL RATE PITCH RATE DEG/SEC • • • • • • • 0. 9 5.0 0.4 2.0 3.0 TIME (SECS.) 1.0 [-40.07 20.04 10.01 ±0.0± 120.0± 120.05 -10.01 -20.0-15.P 10.01 5.0 -20.05 -30.06-165.0₇ 160.0 155.0 150.0 145.0 ġ LONG, VEL. FT/SEC **DECKEES** DEGREES DECKEES

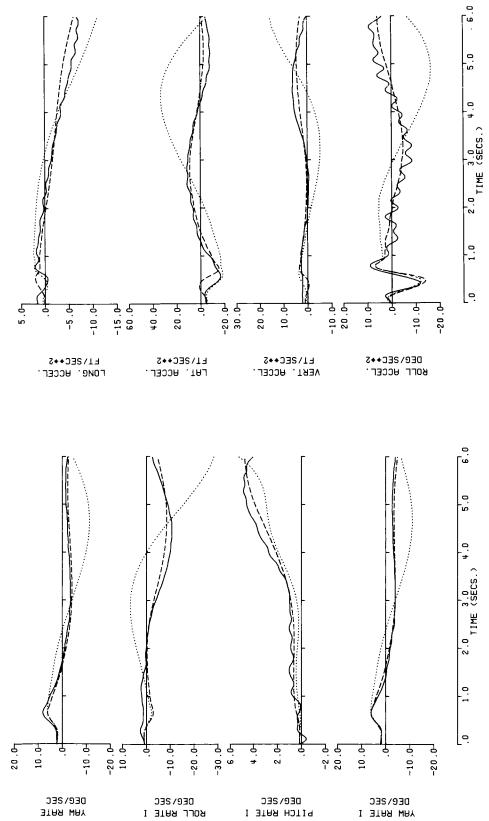
אסרר פוד.

PITCH ATT.

.TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 3). ı 26. Fi gure

Least Square Derivative Model (Method 1)
Max. Likelihood Derivative Model (Method 7) Kalman Filtered Flight Data



Continued. 1 26. Fi gure

. 0.9 5.0 Max. Likelihood Derivative Model (Method 7) Kalman Filtered Flight Data Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) 1.0 <u>|</u> -10.01 2.01 10.01 9. 9.0 THETA TAIL S338030 тНЕТА СОLL. DEGREES ره 0. 5.0 0. 2.0 3.0 TIME (SECS.) .0 ļ 0. 20.05 -20.05-8.0-6.0⁻ -2.0-60.0-Р. 7.0 -3.0--3.5 -2.5-DEG/SEC++5 DECKEES B12 DECKEES 418 PITCH ACCEL.

Figure 26. - Concluded.

[9] 0 . ما Max. Likelihood Derivative Model (Method 7) 0. Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data .0 <u>.</u> 10.01 01.01 -10.01 -20.01 -30.0₺ --0.0} 30.0 20.05 10.0 لان 10 -10 - 10 -5.0 لم. 10 ъ. Р LAT. VEL. FT/SEC VERT. VEL. FT/SEC PITCH RATE DEG/SEC DEC/2EC אסרר RATE و. 9. • • • • • • • 5.0 <u>.</u> 2.0 3'.0 TIME (SECS.) -1-0 15.07 10.01 30.0° 20.09 10.0 الا 10. 20.07 15.0H 10.0 5. P 200.04 160.0 140.0 180.0H DEGREES LONG. VEL. FT/SEC DEGREES DEGREES ROLL ATT. .TIA HOII9 .TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 4). ŧ 27. Figure

5.0 Max. Likelihood Derivative Model (Method 7) ... -_-Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data [o. -10.01-70.05 -5.0 20.04 -10.01-20.03 20.0H P. 01 -10 .0⁻ 10.01 10.0T ل-0.02 9 LONG, ACCEL. FT/SEC++2 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 0E6/SEC++2 5.0 , 1 3.0 TIME (SECS.) 2.0 1.0 6 10.01 ۶. ۶ -10 .01-10 .01 5. P ال-10.00 4 01 9 0. لق. 10 --5.0 DEC/2EC DEQ\ REC

0E0/SEC

PITCH RATE I

ROLL RATE I

YAW RATE

YAW RATE I

Continued. 27. Figure

و. 9 5.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 1) Max. Likelihood Derivative Model (Method 7) o. + 2'.0 3'.0 TIME (SECS.) ļ 0. 4.01 10.92 THETA TAIL SEGREES THETA COLL. DEGREES 0.0 5.0 o. + 2'.0 3'.0 TIME (SECS.) 0. 10.01 -10.01 10.01 -10.01 で. <u>۲</u> 6.0--2.0-5.P 5.9 DEGKEES BIS DEGKEES U12

DE@\@EC++5 YAW ACCEL.

Concluded. ı Figure 27

PITCH ACCEL.

. 0.9 5.0 Max. Likelihood Derivative Model (Method 7) o. Kalman Filtered Flight Data Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) 1.0 0 الا 100 ل-20.001 20.05 -50.0 10.01 50.0F -10.01 -20.03 -20.09 ₽. 0‡ 20.04 -20.0⁻ 5.0-ᆫ -5.0--10.P -15.0-LAT. VEL. FT/SEC VERT. VEL. FT/SEC DEG/SEC ROLL RATE PITCH RATE DEG/SEC 1 .0 5.0 0 2.0 3.0 TIME (SECS.) ... 0. 20.07 -20.05-200.09 10.0 -10.0-ل-20 .05 10 .01 -10.0 -20.04 -30.0d-60.0g 20.04 Ÿ. 190.0 180.0 160.091 P. 04 170.04 YAW ATT. DEGREES LONG, VEL. FT/SEC DECKEES DECKEES ROLL ATT. PITCH ATT.

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 5). ı 58° Figure

5.0 Max. Likelihood Derivative Model (Method 7) Least Square Derivative Model (Method 1) 2.0 3.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 0. -10.01 20.05 -30.05--0.04 20.04 -20.04 -60 .01 10 .01 -10.01 20.05 10.01 DEG/SEC++S LONG. ACCEL. LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 5.0 . • 2'.0 3'.0 TIME (SECS.) 1.0 0. -10.01 30.0-20.0-10 P 60.09 20.05 -20.0⁻ 5.0--10.01 -15.0⁻ 30.0 ₽.0+ 20.04 10.0 -10.0⁻ DEG/SEC PITCH RATE I DEG/SEC DEC/SEC DE0/8EC

ROLL RATE I

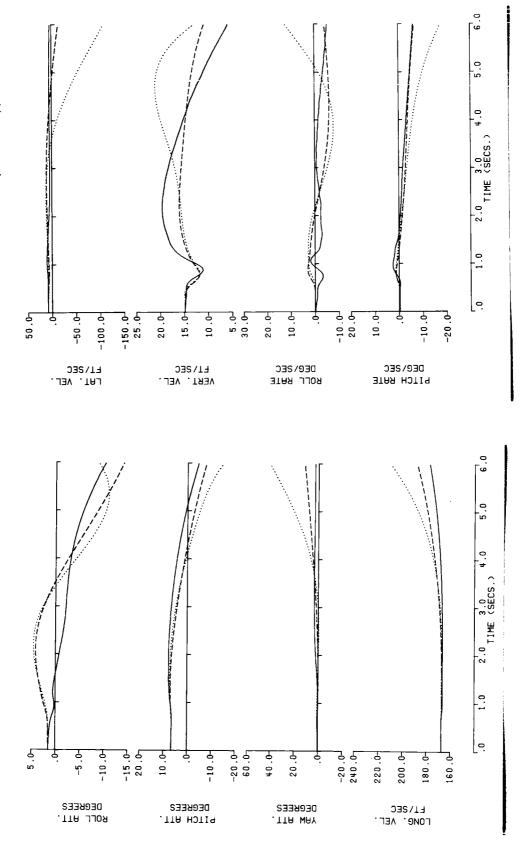
Continued. 28, Figure

YAW RATE I

YAW RATE

و. 19 5.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 1) Max. Likelihood Derivative Model (Method 7) . . 2'.0 3'.0 TIME (SECS.) 1.0 ļ 0. ان. 10 ان. 10 9.5 8 .5 9. P. 9.0 THETA TAIL DEGREES THETA COLL. DEGREES 5.0 . . . 2'.0 3'.0 TIME (SECS.) .0 0. 10.01 ъ. Р -10.01 10.01 -10.01 -10.01 9. P 9.9 -5.0 **8**. ₽. ٦. P -1.9 -5.0--2.P ان 19. ٠ PITCH ACCEL. DEG/SEC++5 DECKEES BIS DECKEES U12

Figure 28. - Concluded.



Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 6). **5**8 Figure

5.0 Max. Likelihood Derivative Model (Method 7) . -Kalman Filtered Flight Data Least Square Derivative Model (Method 1) 2'.0 3'.0 TIME (SECS.) 1.0 <u>|</u> 0. 30.07 20.04 10.0--10.0⁻ لن. 60 10.09 ₽0.0+ 20.04 -20.05-+0.0+ 20.0--20.0--40.0 -20.0--6.04-LONG. ACCEL. FT/SEC++2 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. BEG/SEC++5 [9 5.0 2'.0 3'.0 TIME (SECS.) .. 0. 30.09 20.0 ال- 10. 10.01 **ئ** 9 10.01 ل-0.01--5.0--15.0⁴ -5.0 -10.01 20.04 10.0 لم. 10-0E@\8EC PITCH RATE 1 DEG/SEC 0**5**0/2EC YAW RATE I THM MAY ROLL RATE I

Figure 29. - Continued.

------ Kalman Filtered Flight Data
..... Least Square Derivative Model (Method 1)
----- Max. Likelihood Derivative Model (Method 7)

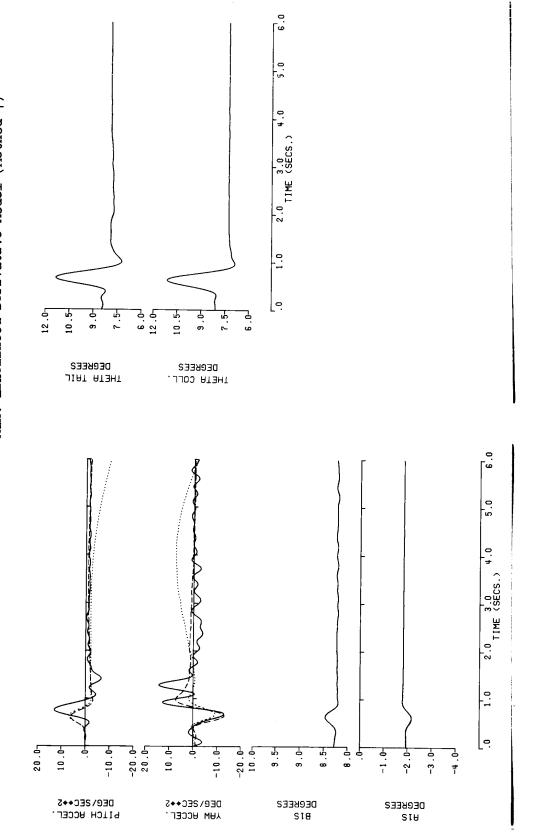


Figure 29. - Concluded.

0. [9 5.0 Max. Likelihood Derivative Model (Method 8) o. + Least Square Derivative Model (Method 2) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 ļ 0. 40.04 30.0F 20.04 25.0-10.01 15.0 10.0 -5.0-15.0-10.01 P. 01 30.09 20.0-15.0 5.0-5.0 LAT. VEL. FT/SEC VERT. VEL. FT/SEC DEG/SEC ROLL RATE PITCH RATE 0. 9 5.0 2.0 3.0 4.0 TIME (SECS.) 0. [0. 140.0+1 170.4 150.0 -2.0⁻ 180.0₋ 160.0 2.0 <u>.</u> -1.0 15.0 9. P ±0.0± æ. œ 20.0H 10.01 10.01 LONG. VEL. YAW ATT. DEGREES ROLL ATT. DEGREES PITCH ATT. DEGREES

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 1). ı œ. Figure

------ Kalman Filtered Flight Data
..... Least Square Derivative Model (Method 2)
----- Max. Likelihood Derivative Model (Method 8)

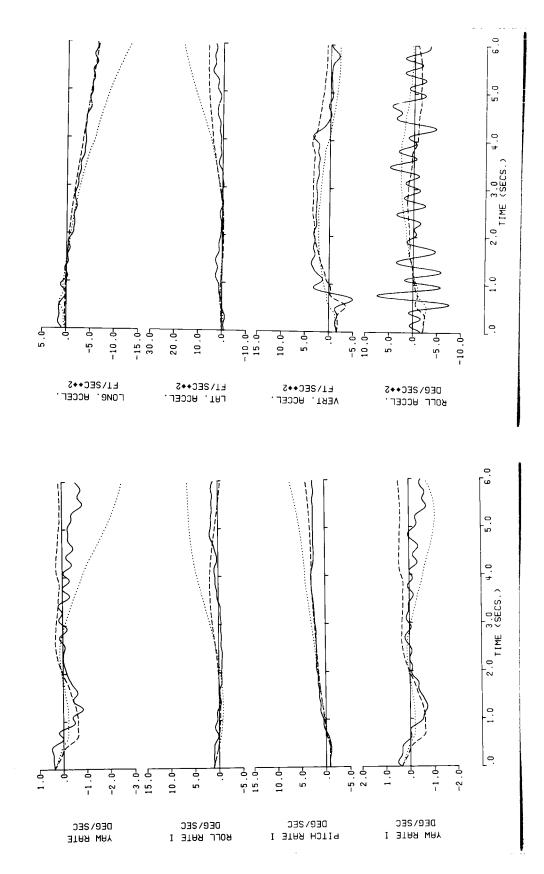


Figure 30. - Continued.

0. 9 5.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 2) Max. Likelihood Derivative Model (Method 8) 0.4 2'.0 3'.0 TIME (SECS.) 0. ه. م 6 .5 6.0¹ 7.5 ٦. 9.0 8.5 THETA TAIL DEGREES тНЕТА СОLL. DEGREES و <u>.</u> 0 5.0 0. 2'.0 3'.0 TIME (SECS.) -1-0. -10.01 -0.01 7.0-6. P. -2.5--3.0 -3.5 15.07 15 P. -5.01 10.01 5. P 5. P -5.0 DECKEES BIS DEGKEES U12 DEG/SEC++5 PITCH ACCEL.

Figure 30. - Concluded.

5.0 Max. Likelihood Derivative Model (Method 8) 0. Kalman Filtered Flight Data Least Square Derivative Model (Method 2) 2'.0 3'.0 TIME (SECS.) 1.0 <u>|</u> 40.04 20.02 25.09 80.0H 60.0 20.04 15.0 10.P 5.0¹ 5.0 -5.0-3.07 9 2.0 -10.0-VERT. VEL. FT/SEC LAT. VEL. FT/SEC PEG/SEC PITCH RATE DEG/SEC 9 5.0 . . . 2'.0 3'.0 TIME (SECS.) 1.0 0 30.05 -10 .01-20 .03 20.0E 10.01 15.0-10. OI ة 1. و. ٦. ٩ -10.0- 180.0-5.0 9 -5.0 175.0-170.0-165.0-160.031 ROLL ATT. DEGREES DECKEES DEGREES E1/SEC PITCH ATT. .TIA WAY LONG. VEL.

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 2). 1 31. Figure

Kalman Filtered Flight Data Least Square Derivative Model (Method 2) Max. Likelihood Derivative Model (Method 8)

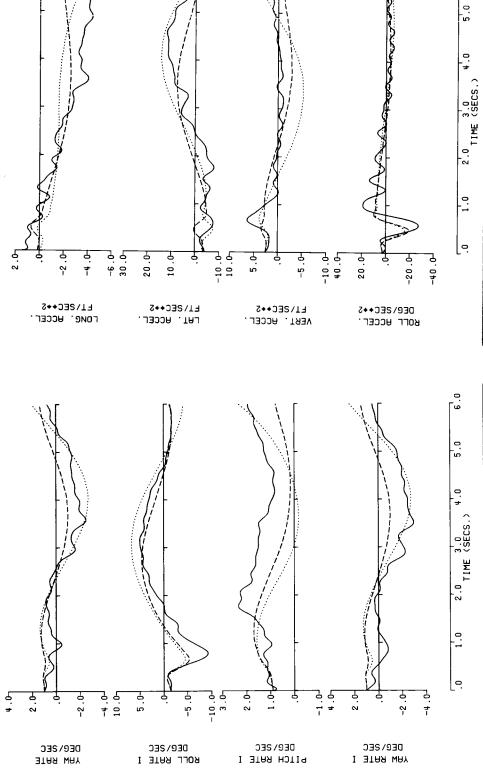


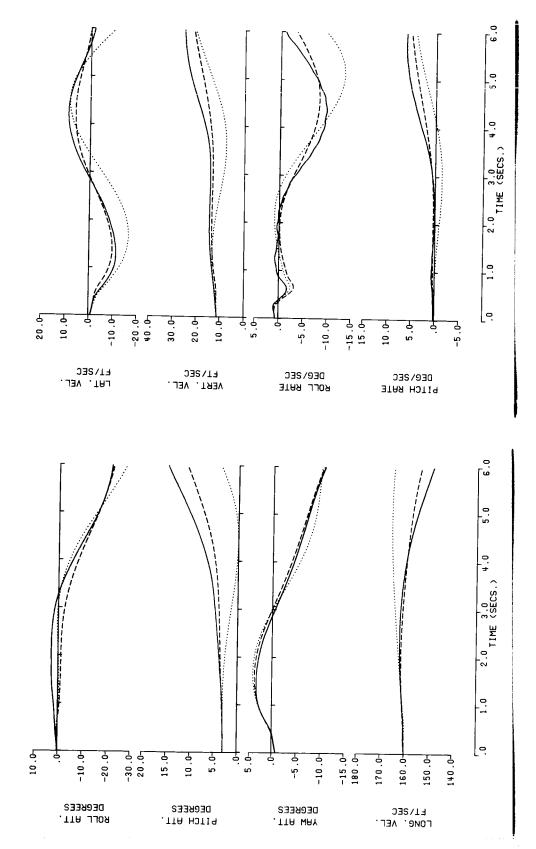
Figure 31. - Continued.

ر 9 . و

6.0 5.0 Max. Likelihood Derivative Model (Method 8) Kalman Filtered Flight Data Least Square Derivative Model (Method 2) 2.0 3.0 TIME (SECS.) 1,0 [0. 6.01 10.01 8.5 9. J 9.5 9.0 THETH THIL DEGREES тНЕТА СОLL. ВЗЗЯВЗО . 9 ص_ . 4.0 2'.0 3'.0 TIME (SECS.) 0. -2.0-10.01 5.0 ж. Б -10 .01 -0.01 -1.0 9.0 -2.0-DE@\REC++5 DEGKEES 812 DECKEES 412 DEC/SEC++5 PITCH ACCEL. YAM ACCEL.

Figure 31. - Concluded.

------- Kalman Filtered Flight Data Least Square Derivative Model (Method 2) ----- Max. Likelihood Derivative Model (Method 8)



Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 3). ı 32, Figure

5.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 2) Max. Likelihood Derivative Model (Method 8) 0 ± 2'.0 3'.0 TIME (SECS.) [0 -10.01 20.04 -16.04 -10.0 LONG. ACCEL. LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 BEG/SEC++5 6.0 5.0 2'.0 3'.0 TIME (SECS.) 1.0 6 -2.0-10.0--5.04 -10.01 -10 . 머 PITCH RATE I DEG/SEC YAW RATE DEG/SEC ROLL RATE I DEG/SEC DEC/SEC YAW RATE I

Continued.

32

Figure

102

Least Square Derivative Model (Method 2)
Max. Likelihood Derivative Model (Method 8) <u>,</u> 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 0. 10.01 2. P. ٩. ٩. 8.0 THETA TAIL DEGREES тнетА СОLL. ОЕСВЕЕS 0. 6.0 5.0 0. 2'.0 3'.0 TIME (SECS.) .0 6 -2.0-60.0-20.05 -20.05--8.07 . 6. 6. 19. 6. 2 P. P <u>0</u> ٦. -2.5--3.5 -3.P

PITCH ACCEL.

DEG/SEC++5

DECKEES B12

رن 10.6

5.0

Figure 32. - Concluded.

DECKEES UIS

. . 0 <u>ص</u> Max. Likelihood Derivative Model (Method 8) 0 2 Kalman Filtered Flight Data Least Square Derivative Model (Method 2) 2'.0 3'.0 TIME (SECS.) 1.0 0. 5.01 15.0 10.01 20.05 2.0 ٦ † ل-30.06 10.01 10.01 -10.0 -20.0-25.07 15.0 PITCH RATE DEG/SEC LAT, VEL. FT/SEC VERT, VEL. FT/SEC BOLL RATE • • • • • • 6.0 5.0 2'.0 3'.0 TIME (SECS.) .0 0. 15.0م 10.0t 30.0° 10.01 20.05 الا 10. 8.07 P. 9 2.9 220.07 200.04 180.04 160.04 DEGREES YAW ATT. DEGREES DECKEES LI\SEC . אסרר אדד TITH HOTI9 LONG. VEL.

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver μ). ı 33 Figure

0. 9 5.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 2) Max. Likelihood Derivative Model (Method 8) 0 + 2'.0 3'.0 TIME (SECS.) 1.0e. 30.05 20.0-10.01 -10.01-20.05 10.01 -10.01-20.05 30.07 10.0-20.0--10.01-20.05 10.0-FI/SEC++2 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 BEG/SEC++5 5.0 2'.0 3'.0 TIME (SECS.) <u>|</u> 0. 6.07 9 -2.0 6.07 **DE**@/ **2E**C PITCH RATE I DEG/SEC DE6/SEC DEC\2EC YAW RATE ROLL RATE I YAW RATE I

Figure 33. - Continued.

----- Kalman Filtered Flight Data
..... Least Square Derivative Model (Method 2)
----- Max. Likelihood Derivative Model (Method 8)

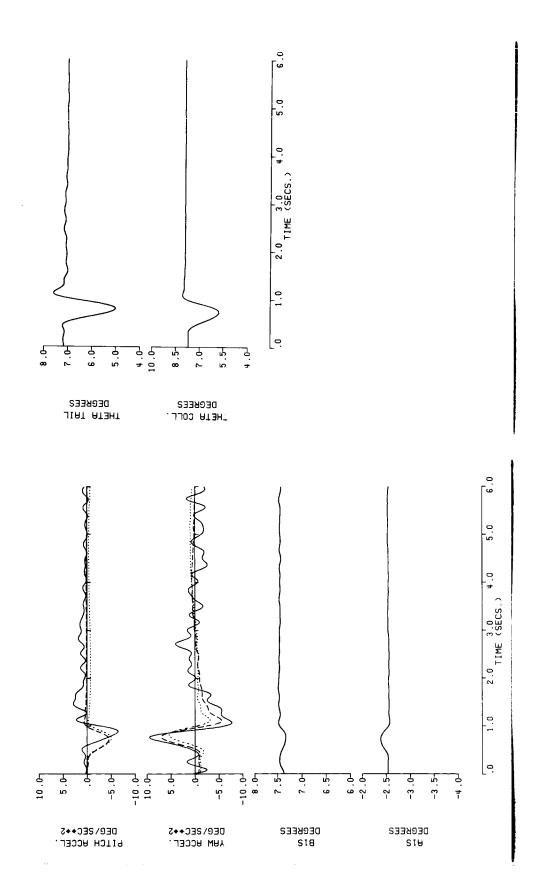


Figure 33 - Concluded.

و. 10 0 ----- Max. Likelihood Derivative Model (Method 8) <u>.</u> Least Square Derivative Model (Method 2) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data le. -10.01 10.01 -20 .05-30 .05 20.0 ₽.04 20.05 10.01 5.0 -10.0120.05 10.01 ال-20.00 -10.01 LAT. VEL. FT/SEC VERT. VEL. FT/SEC OEG/SEC PITCH RATE .0 5.0 . _ 2'.0 3'.0 TIME (SECS.) 1.0 .و 10.01 -10.01 -20.0- -30.05− 20.05 10.01 -10.01 -20.0⁻ 15.0-10.0T 5.0 -5.0⁻ 170.0 160.04 9 190.0 180.0 ROLL ATT. DEGREES PITCH ATT. DEGREES LONG. VEL. DEGREES

TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 5). 1 ₹ 3 Figure

------ Kalman Filtered Flight Data Least Square Derivative Model (Method 2) ----- Max. Likelihood Derivative Model (Method 8)

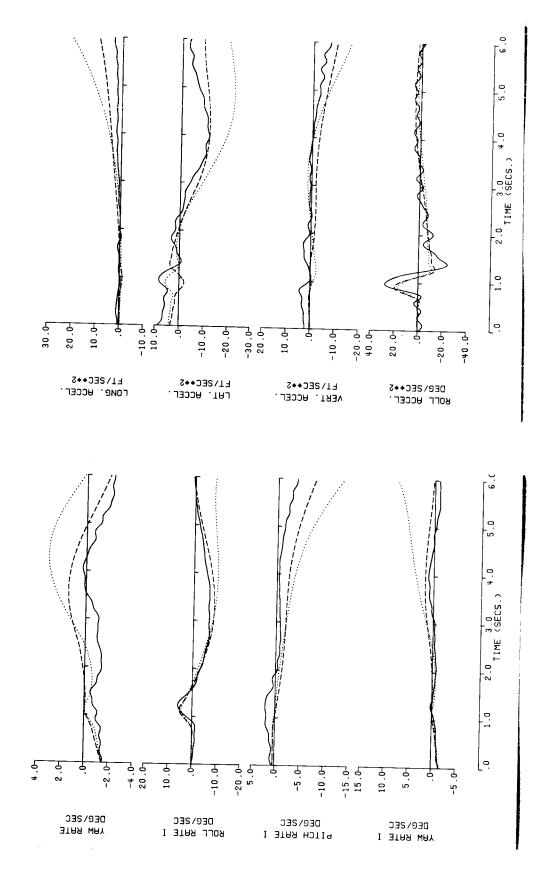


Figure 34. - Continued.

5.0 Least Square Derivative Model (Method 2) 2.0 3.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 [<u>-</u> 9.0 F 8.01 10.01 9.5 ·5-8.5 9.0 THETA TAIL DEGREES тнетн сосс. ОЕБВЕЕS 6.0 5.0 . . 2.0 3.0 TIME (SECS.) 0. ļ۰. 10.01 5.0 -10.01 15.0 10.01 -5.0-0.01 9.0 ٩. 6.0-1.0 -5.0-5.0 <u>8</u> -2.0년 J. 6-PITCH ACCEL. DEGREES 918 VAW ACCEL. DEGREES SIB

Figure 34. - Concluded.

5.0 Max. Likelihood Derivative Model (Method 8) °. Kalman Filtered Flight Data Least Square Derivative Model (Method 2) 2'.0 3'.0 TIME (SECS.) 1,0 0 20.07 -40.01 لم. 60-20.05 15.0 10.0H 5.0 20.05 10.01 ل-20 ـ 20 10 . 01 -20.05 -30.08--10.다 LAT. VEL. FT/SEC **VERT. VEL.** FT/SEC DEG/SEC BOLL RATE PITCH RATE DEG/SEC • • • • • • • 5.0 , 0. 2'.0 3'.0 TIME (SECS.) 1.0 0 40.0+ 20.05 160.0-_0.04-10.01 -10.0+-20.04 -30 .05--0.08 20.04 10.0-L0.01-240.07 220.04 200.0-180.0-PITCH ATT. DEGREES LONG. VE DECKEES DEGREES ROLL ATT. ΛΕΓ. .IIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 6). ı 35. Figure

Kalman Filtered Flight Data Least Square Derivative Model (Method 2) Max. Likelihood Derivative Model (Method 8)

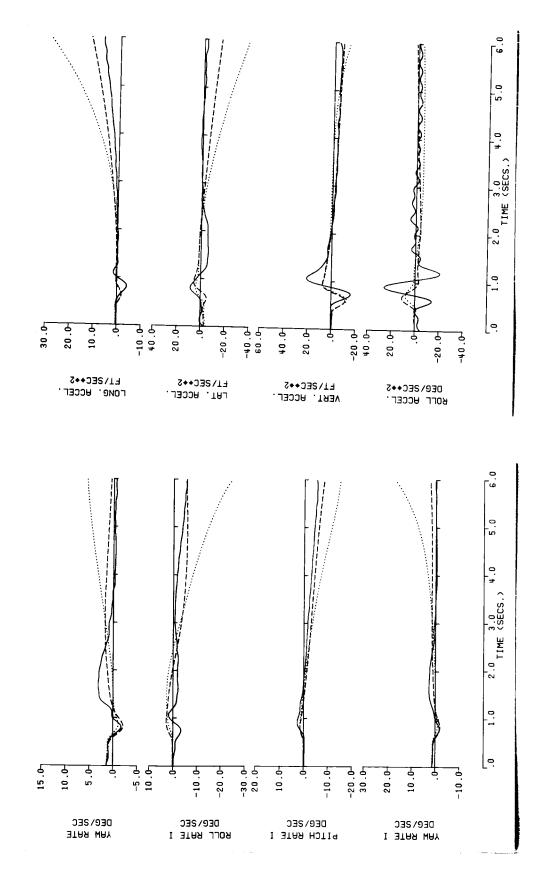


Figure 35. - Continued.

0.9 5.0 ----- Max. Likelihood Derivative Model (Method 8) Least Square Derivative Model (Method 2) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 [<u>o</u> 9. P 7.5 6.01 12.0 10.5 -9. 6.0 THETA TAIL DEGREES THETA COLL. DEGREES 0. [9 5.0 0 2'.0 3'.0 TIME (SECS.) 1.0 0. 30.0 -20.05-10.01 ₽.0 -10.0⁻ 20.04 10.01 10.01 -10.01 9. <u>1</u>. -3.P DEGKEES 918 PITCH ACCEL. DEG/SEC++5 DEGKEES BIS

Figure 35. - Concluded.

و. 9 5.0 Max. Likelihood Derivative Model (Method 9) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) 25.07 5.0 15.0 ان 10 -2.0--0.8 20.04 15.0-30.09 25.0H 20.04 6.0 <u>ا</u> ÷ ₽. 2.0-PITCH RATE DEG/SEC LAT. VEL. FT/SEC VERT. VEL. FT/SEC DEG/SEC BOLL RATE ٥. 9 5.0 2'.0 3'.0 TIME (SECS.) .. [o. 1.0 -5.0⁴ -1.0⁻1 165.0 لل 150 و1 5.0 10.01 5.9 Ψ 160.0 155.0 15.0 ਤੁ ROLL ATT. DEGREES PITCH ATT. DEGREES LONG, VEL. DEGREES .TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 1). 1 36 Figure

5.0 Max. Likelihood Derivative Model (Method 9) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) 1.0 P. -10.01 10.01 BECYSEC++S BOLL ACCEL. LONG, ACCEL. LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 6.0 5.0 0. ÷ 2.0 3'.0 TIME (SECS.) 1.0 o. PITCH RATE I DEG/SEC DEG/SEC BOLL RATE I DEC/SEC YAW RATE

Figure 36. - Continued.

0. 9 5.0 Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data ļ 0. ه. م 6.01 10.01 6.5 9. P . 5 THETA TAIL DEGREES THETA COLL. DEGREES ر 9.0 5.0 2.0 3.0 TIME (SECS.) .. 0. -10.01 -10.01 -2.07 10.01 -5.01 10.01 5.0 9. P. **9**. ٠. ٩ о. Р -2.5 Jo. ₹ PITCH ACCEL. DEG/SEC++2 DEG/SEC++5 DEGKEES B18 DEGKEES H18

Figure 36. - Concluded.

0. 9 5.0 . -2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data [0. % ₽.0% 25.0⊢ ; ; ; 2.P 20.P 9. 09 50.05 40.01 15.P –10.0<u>1</u> PITCH RATE DEG/SEC LAT. VEL. FT/SEC VERT. VEL. FT/SEC BEG/SEC ۰. 0.9 2.0 3'.0 TIME (SECS.) 1.0 0. 10.01 الم. 10 20.02 5.P -5.0 10.01 لارا 10.0 180.0 160.0 15.P 10.01 165.0 170.04 ġ ъ. Р Ģ. 175.0 ROLL ATT. DEGREES P11CH ATT. DEGREES LONG. VEL. FT/SEC DEGREES TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 2). 1 37. Figure

. 9 0. 0. Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 2'.0 3'.0 TIME (SECS.) 1.0 0. 10.01 ٦. ٩ 30.05 20.04 لل. 10 -15.09 10. P. ₽. å. ₽. ₽. الم. 0 20.0 -20. 머 LONG. ACCEL. LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 BEG/SEC++5 . 6.0 5.0 2.0 3.0 TIME (SECS.) 1.0 ļ 0. 3.0 4 t ٦. م DEG/SEC ROLL RATE I PITCH RATE I DEG/SEC DE0/8EC YAW RATE I

Figure 37. - Continued.

6.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 6 8.5 THETA TAIL DEGREES THETA COLL. DEGREES 5.0 2'.0 3'.0 TIME (SECS.) -10.01 -10.01 당 2.01 10.04 م. **.** <u>-1.9</u> 2 PITCH ACCEL. DEG/SEC++2 DEG/SEC++5 DECKEES BIS DEGKEES U12

Figure 37. - Concluded.

0. 9 2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data -20.05 30.09 20.09 -10.01 15.0⊢ -10.01 е. 9 10.01 25.0H 20.0F 3. 01 9. 02 5. P 5.0 <u>P</u> LAT. VEL. FT/SEC VERT. VEL. FT/SEC DEG/SEC ROLL RATE PITCH RATE 0. 9 5.0 0. 2.0 3.0 TIME (SECS.) 1.0 0 -20 .0⁻ 145.0 10.91 -30.05 -20.05 10.0I -10.0H 160.0 150.04 20.07 155.0H -20.04 15.0 10.01 5.P P. 01-Ÿ LONG, VEL. FT/SEC ROLL ATT. DEGREES DEGREES PITCH ATT. DEGREES . TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 3). ı 38 Fi gure

0. 9 5.0 ----- Kalman Filtered Flight Data Least Square Derivative Model (Method 3) ----- Max. Likelihood Derivative Model (Method 9) 2'.0 3'.0 TIME (SECS.) 0.1 0. -10.01 0. P. -5.0² ٦٥.01 الا 10.00 20.09 -20 .05-15 .09 5.P 0. P -10.면 9.01 -20.0 DEG/SEC++5 VERT. ACCEL FT/SEC++2 LAT, ACCEL. FT/SEC++2 EI/SEC++5 гоие: ыссег: 0.9 . • 2.0 3.0 TIME (SECS.) -1 ۰. 15.9 -5.0 -5.0 10. O. ج 1 -10.0H 2 P. -2.0-10.0--5.0 -10.01 -5.0 DEG/SEC ROLL RATE I DEG/SEC PITCH RATE I DEG/SEC YAW RATE I

Figure 38 - Continued.

0. 9 5.0 . • 2.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) --0 2.01 10.01 9.5 DECKEES THETA COLL. DEGREES JIAT ATƏHT 6.0 5.0 0 2.0 3.0 TIME (SECS.) 1.0 ļ 0. . Р. لن. 20. 19.9 2._P -2.02 ₽.0 20.04 <u>۲</u> ٦- 2- 0 -2.5-P. 4 6.5 ٦. ‡ PITCH ACCEL. DEG/SEC++5 DECKEES DECKEES U12 នខេ

Figure 38. - Concluded.

5.0 <u>0</u> 2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data -20.05-30.09 20.04 10.01 15.0 5.0-10.9 اء 1 <u>P</u>. 01 -10.01 25.0 15.0 7. DEG/SEC מסרר משוב PITCH RATE DEG/SEC LAT. VEL. FT/SEC VERT. VEL. FT/SEC 0.9 5.0 2.0 3'.0 TIME (SECS.) .0 [0. 140.041 2 Р. 170.0 160.0引 150.04 7 <u>₹</u> -2.0⁻ -20.0⁻ 15.0 5.0 **8** Р. P. 9 6.9 2. P. 10.01 LONG. VEL. FT/SEC DEGREES DEGREES DEGREES .TIA WAY ROLL ATT. .IIA HOTI9

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 4). ı 39 Figure

0. [9

ا 9. 5.0 0. ------ Kalman Filtered Flight Data Least Square Derivative Model (Method 3) ----- Max. Likelihood Derivative Model (Method 9) 2.0 3.0 TIME (SECS.) ... 0 30.05 20.0H 10.01 -10.01-20.09 P. 01 -10.P لم. 20 10.01 -10.01 --0.01 ال- 10.0 BEG/SEC++2 VERT. ACCEL. FT/SEC++2 LAT. ACCEL. FT/SEC++2 LONG. ACCEL. 2'.0 3'.0 TIME (SECS.) 1.0 [-<u>후</u> 10.0I BOLL RATE I PITCH RATE I DEG/SEC DEG/SEC DE0/8EC YAW RATE

Figure 39 - Continued.

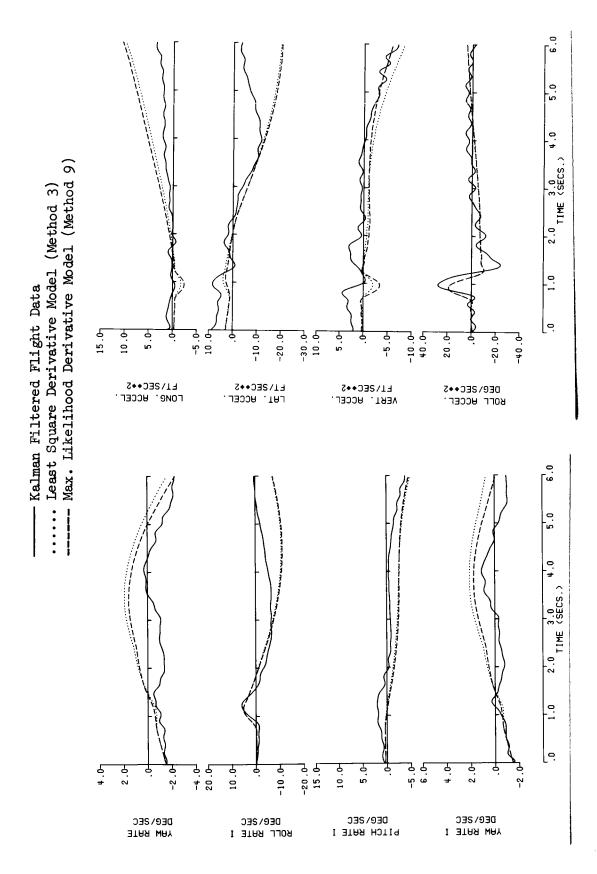
0.9 5.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 2'.0 3'.0 TIME (SECS.) .. -<u>1</u> ļ 0. ±.01 10.01 8 .5 THETA COLL. DEGREES DEGREES THETA TAIL 0. 9 2'.0 3'.0 TIME (SECS.) 0. 10.01 ال- 10.00 10.01 م ٩ 8. L 6.6 P. 6.9 Ъ. PITCH ACCEL. DEG/SEC++2 DEG/SEC++5 DECKEES BIS DEGKEES U12

Figure 39. - Concluded.

.. .. 5.0 ******************************** . --2.0 3.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data <u>|</u> 0. -20.05 -20.08 9.04 20.0H 9 20.09 10.01 -10.01 --20.03 -20.05-10.01 -10.0 ٩.3 ام. م LAT. VEL. FT/SEC VERT. VEL. FT/SEC BEG/SEC PITCH RATE DEG/SEC 9.0 5.0 . • 2.0 3'.0 TIME (SECS.) -1 [0. 10.01 -30 .05-10 .01 5. P -5.0 -10.01-15.0-٦. ٩ -5.0⁻ 200.09 -10.P 10. P. 190.0 لص. 160 9 180.0 170.P YAW ATT. DEGREES DEGREES DEGREES EI/SEC ROLL ATT. PITCH ATT. LONG, VEL.

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 5). ı 10, Figure

Figure 40. - Continued.



<u>6</u>.0 2.0 3.0 TIME (SECS.) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) [e 10.01 9. P. THETA TAIL S338530 OEGKEES THETH COLL. 0. 9 5.0 0. 2.0 3'.0 TIME (SECS.) 1.0 <u>-</u> 15.0 ٦. * 10.01 م ٩ 15.0 10.0 _5.01 _10.01 9.0 요. <u>۲</u> **б**. ا. 1. ۵. م 10.01 PITCH ACCEL.
DEG/SEC++2 DEGKEES B12 DEGKEES UIS DE@\ 2EC++5 YAW ACCEL.

Figure 40. - Concluded.

0. 9 5.0 2.0 3.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) Kalman Filtered Flight Data 0. 20.09 요. 01 -10.P -20 .05 -25 .09 20.0-15.0 10.P 5.0 20.09 10.01 الم. 20 10.01 <u>г</u> -5.0 VERT, VEL. FT/SEC DEG/SEC BOLL RATE DEQ\ SEC LAT. VEL. FI/SEC PITCH RATE 0 2'.0 3'.0 TIME (SECS.) 0. 20.05 -5.0⁻ 200.0₋ -20.04 _10.0± 20.05 10.01 لوں 20 15.0م P. 01 5. P 180.04 170.04 160.04 -10.0T 190.04 LONG, VEL. DEGREES DEGREES **DEGREES** . אסרר אזד. TITH HOTI9 .TTA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (100 knots, Maneuver 6). ı <u>†</u> Figure

0. 9 5.0 . • 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 1.0 0 10 . O -10.01 -10.01 -10.면 60.09 £0.0± 20.04 -20 .01 20.05 -40.01 ال-0.06 FI/SEC++2 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 DEG/SEC++5 <u>و</u>. 0 5.0 0. 2.0 3.0 TIME (SECS.) 1.0 [o 20.52 P. P. 10.0 -20.05 -10.01 -10.01 15.0₇ 10.0 -10.01 PITCH RATE I DEG/SEC DEG/SEC BOCK BATE I DEC/SEC YAW RATE YAW RATE I

Figure 41. - Continued.

6.0 5.0 . -2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) 0. 6.01 12.0 9. THETA TAIL DEGREES THETA COLL. DEGREES 5.0 2'.0 3'.0 TIME (SECS.) .. 6 -20.05 10.01 -10.01 -20.05 10.01 <u>∞</u> 2 ₽ 20.0H <u>-1</u>.9 9.6 ----DECKEES U12 PITCH ACCEL. DEC\ZEC++5 DEGKEES B18

Figure 41 - Concluded.

9.0 .0 .0 . -2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 4) .0 Kalman Filtered Flight Data ٥. ₩ 1. 6. 30.0 20.04 10.01 25.0-15.P д. 01 20.04 2. P 15.0 1.0 **5**. L**AT.** VEL. FT/SEC VERT. VEL. FT/SEC PIICH RATE DEG/SEC DEG/SEC אסרר מפוב [9 0.9 5.0 0. 2'.0 3'.0 TIME (SECS.) 1.0 ļ 0. ج 9 <u>P</u> -1.0⁻ 40.07 30.0 20.0 10.01 <u>r</u> 170.04 160.04 150.0H 140.041 ROLL ATT. DEGREES P1TCH ATT. **DE**GREES YAW ATT. DEGREES LONG, VEL. FT/SEC

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 1). ı 42. Figure

----- Kalman Filtered Flight Data ---- Max. Likelihood Derivative Model (Method 4)

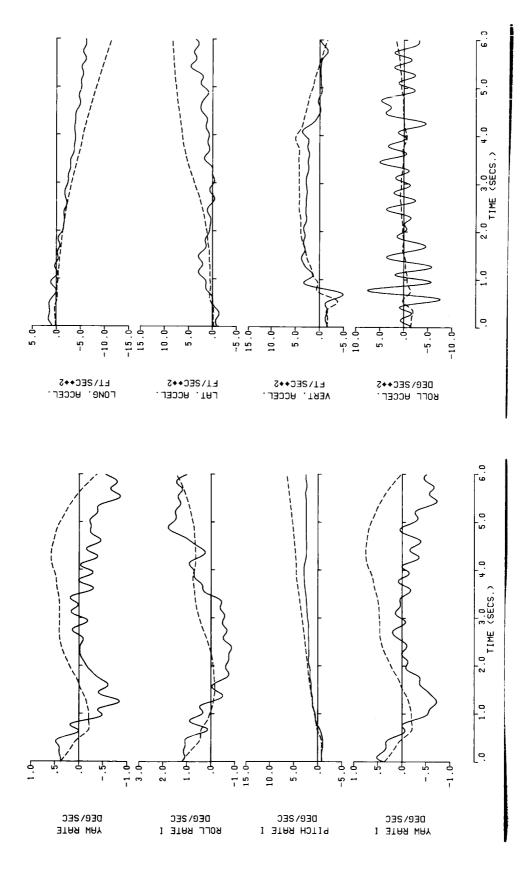


Figure 42. - Continued.

Kalman Filtered Flight Data Max. Likelihood Derivative Model (Method 4)

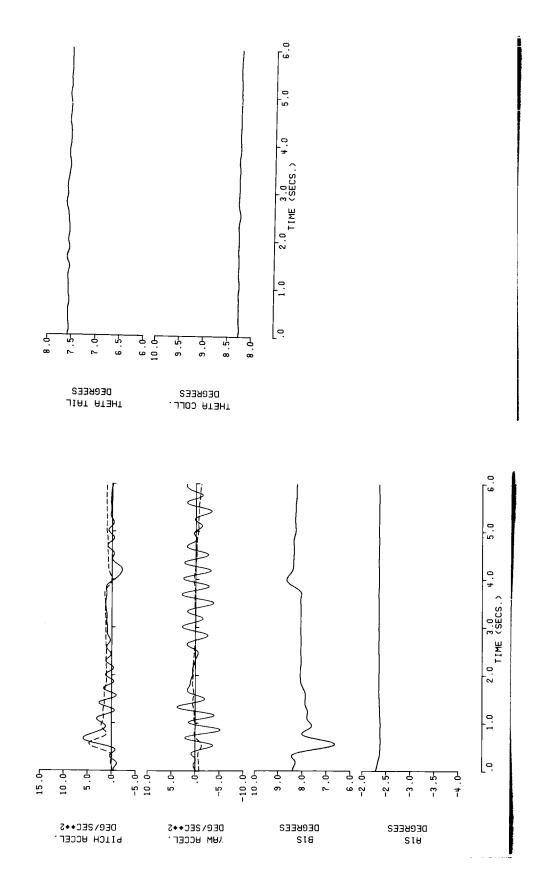
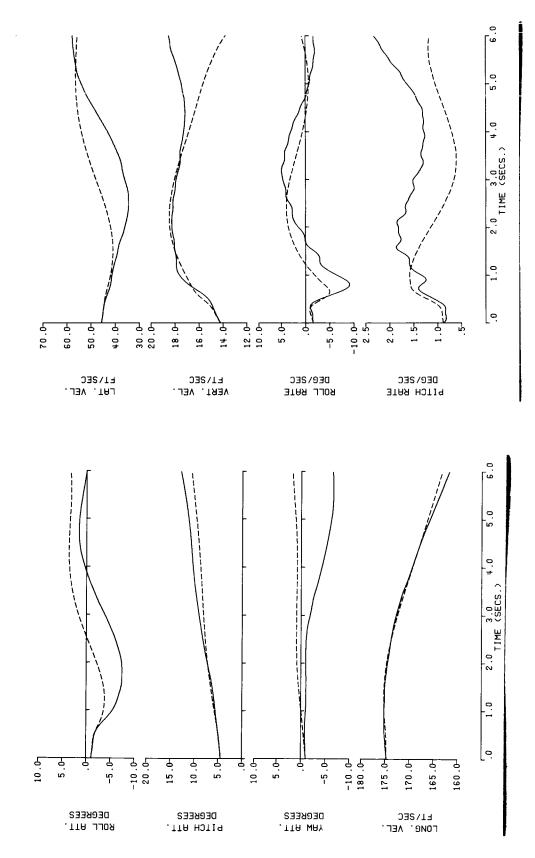


Figure 42. - Concluded.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 2). ı Figure 43.

Kalman Filtered Flight Data Max. Likelihood Derivative Model (Method 4) ₽. -2.0 д. 9. 20.08 20.09 10.01 4 –10.0[—] 15.0 10.P 5. 0. 10. 0. 20.09 LONG, ACCEL. FT/SEC++2 LAT, ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 BEG/SEC++5 2._P 4 5 9. 9. 5 P ل-20.00 ر5.5 -2.04 DE0/8EC ROLL RATE I PITCH RATE I DEG/SEC DEGNSEC

YAW RATE

Continued. ı <u>£</u> Figure

5.0

0.

2.0 3.0 TIME (SECS.)

1.0

0.

5.0

. .

2.0 3.0 TIME (SECS.)

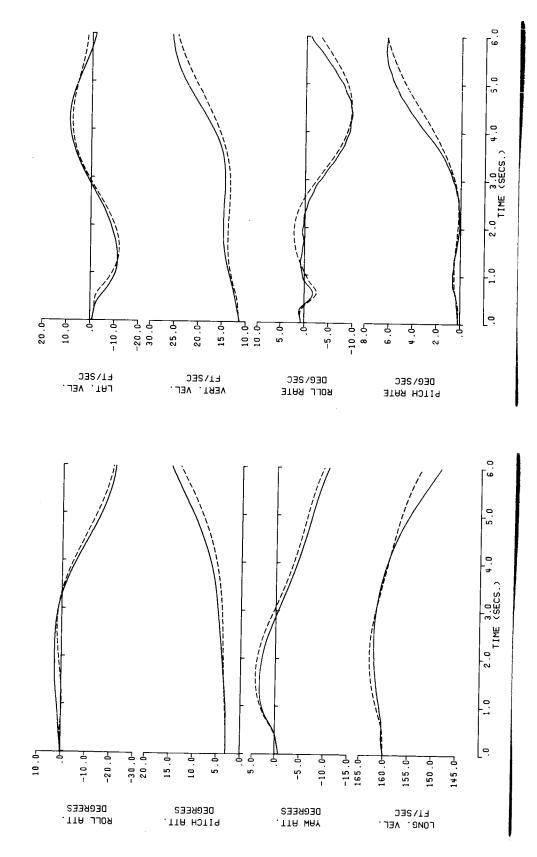
1.0

[-:

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4) 0. [0 ۲. ь. от Р. о. و بې 9.0 THETA TAIL SEGREES тнетА СОLL. ОЕСВЕЕS 5.0 0. 2'.0 3'.0 TIME (SECS.) 6.9 2.0 6 9 ل-2 ـ 0 ـ 10 ـ 10 لن 10.01-10.01 9.5 子.5 9.0 2. q. -1.0 PITCH ACCEL. DEG/SEC++2 DEG/SEC++5 DECKEES 812 DEGKEES U12

Figure 43 - Concluded.

------ Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 3). †† Figure

----- Kalman Filtered Flight Data

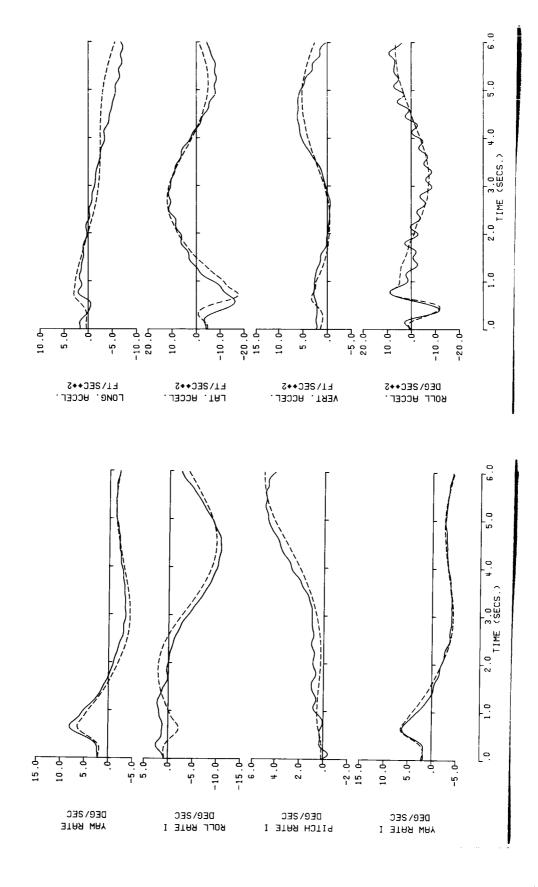
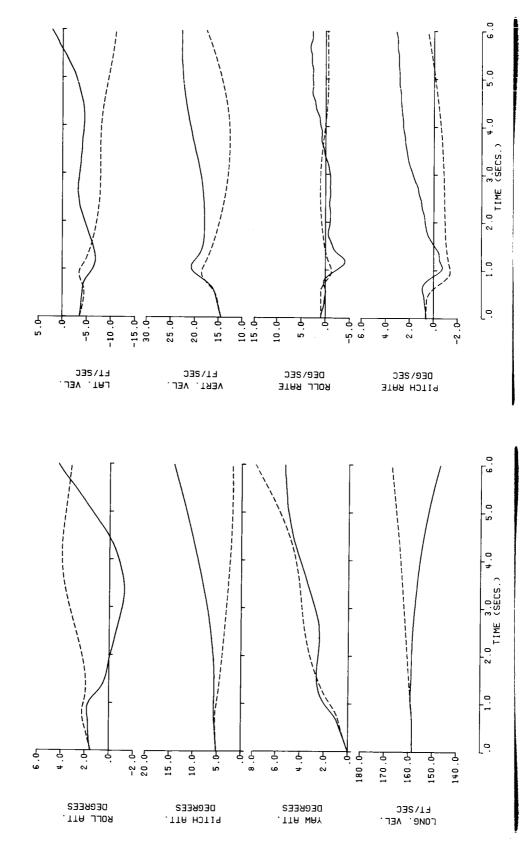


Figure $^{\mu\mu}$. - Continued.

5.0 2.0 3.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 4) 1.0 Kalman Filtered Flight Data 6. 10.01 2.01 10.01 9.5 9. 8.5 °. ⊿. THETA TAIL DEGREES THETA COLL. DEGREES L9 5.0 o. 2'.0 3'.0 TIME (SECS.) 1.0 0 2. P -2.0--0.03 9. 20.05 ₽. 0‡ ------2.5--3.5-DEG/SEC++2 DEGKEES 918 DEC/SEC++5 DEGKEES YAW ACCEL. S18

Figure 44. - Concluded.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver μ). 1 45. Figure

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)

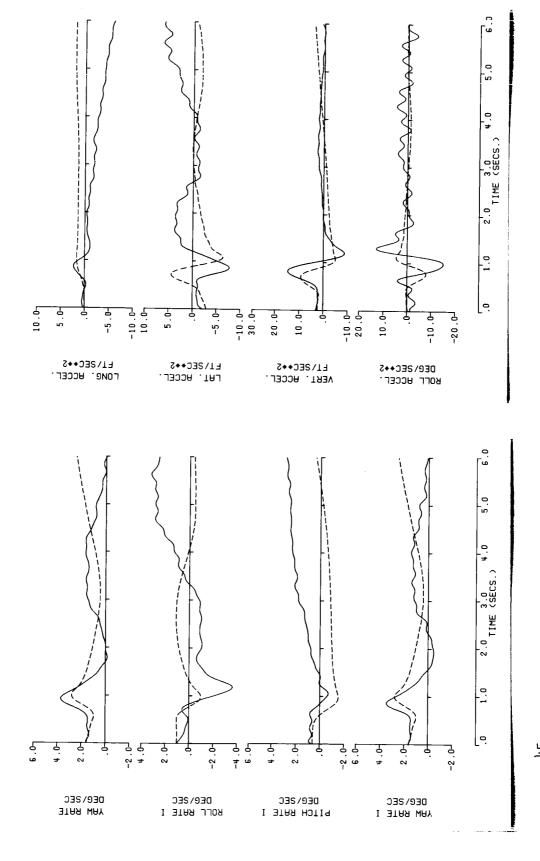


Figure 45. - Continued.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)

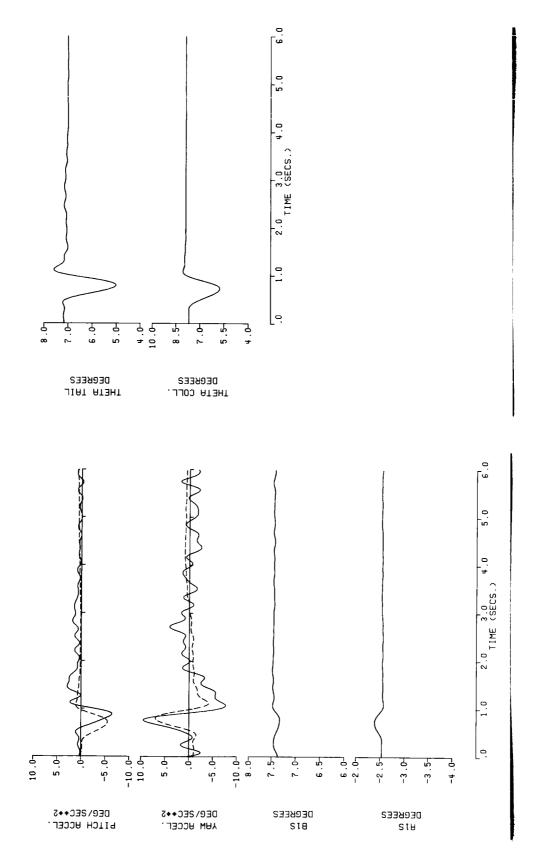


Figure 45. - Concluded.

5.0 . -2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 4) 1.0 Kalman Filtered Flight Data <u>|</u> 0. 60.09 20.09 -20 .05-20 .05 9.01 -10.01 ٦0 . 01 م. -5.0 -10.01 -5.0 5.0 -15.07 -10.01 LAT, VEL. FT/SEC VERT. VEL. FT/SEC ROLL RATE PITCH RATE DEG/SEC ٠. 5.0 0 2.0 3.0 TIME (SECS.) .0 6 5.9 5.0 -10.01 لا 15.0ً 10.01 -20.04 -30.08--2.0 -5.0 -10.P -1.9 200.07 160.04 -3.P 9. 4 170.P 190.0 180.0-ROLL ATT. DEGREES DEGKEES DEGREES LONG. VEL. FT/SEC PITCH ATT. .TIA WAY

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 5). ı , 16 Figure

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)

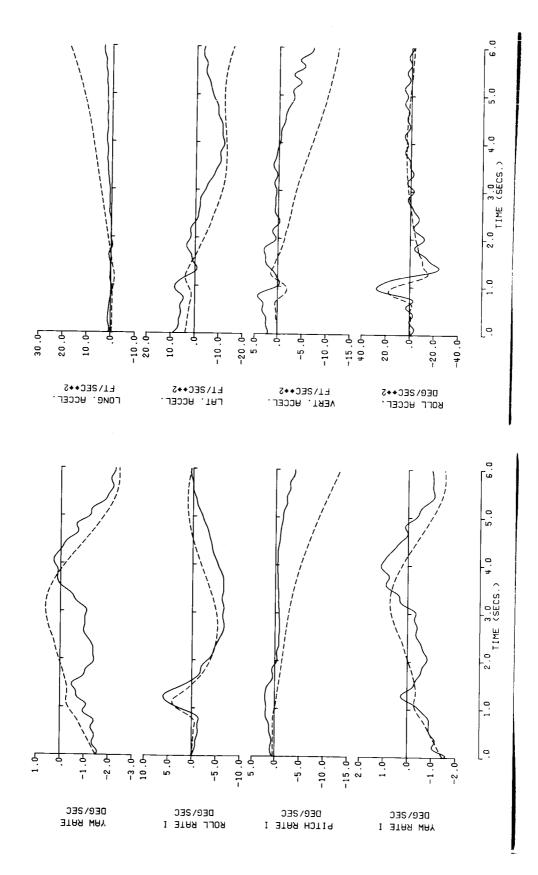


Figure 46. - Continued.

Max. Likelihood Derivative Model (Method 4) Kalman Filtered Flight Data

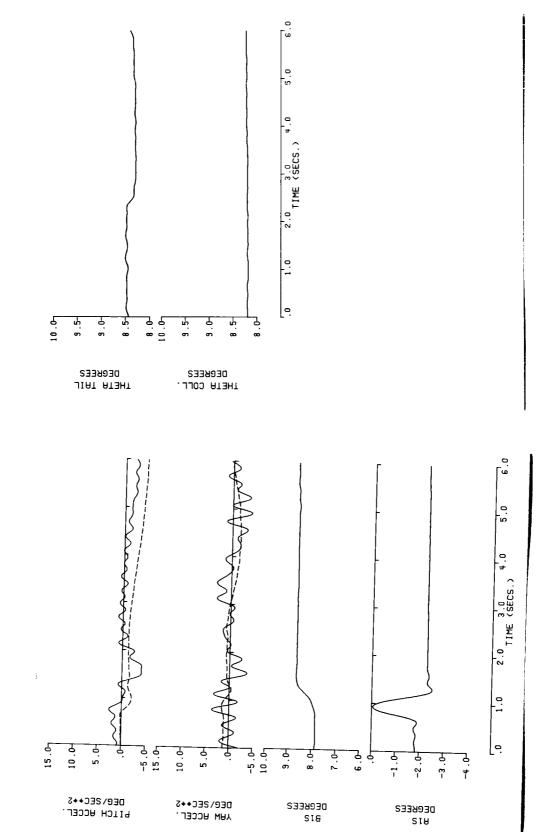
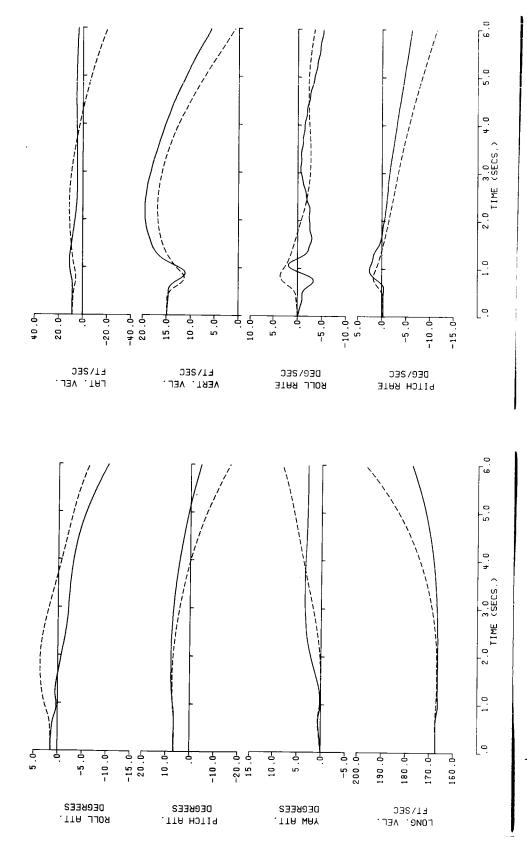


Figure 46. - Concluded.

----- Max. Likelihood Derivative Model (Method 4)



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 6). 1 77 Figure

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method μ)

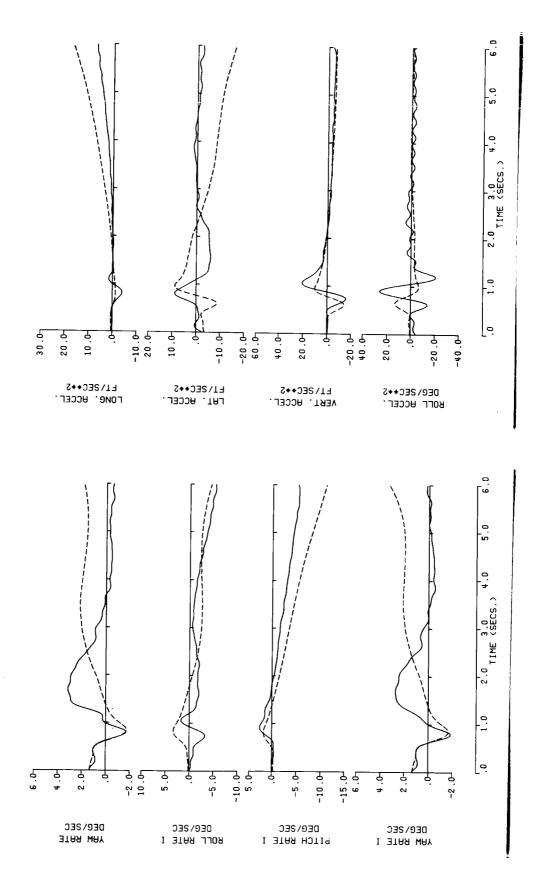


Figure 47. - Continued.

6.0¹ THETA COLL. DEGREES THETA TAIL DEGREES 0 ۲ω 5.0 2.0 3.0 TIME (SECS.) Concluded. 1,0 Figure 47. <u>_</u>-30.05 10.0 -10.0⁻ 10.0 -20.05-10.01 8.0 20.0H -1.9 9.0 -2.0--3.0-9. -10.0-PITCH ACCEL. DEG\ZEC++5 DECKEES BIS DECKEES U13

5.0

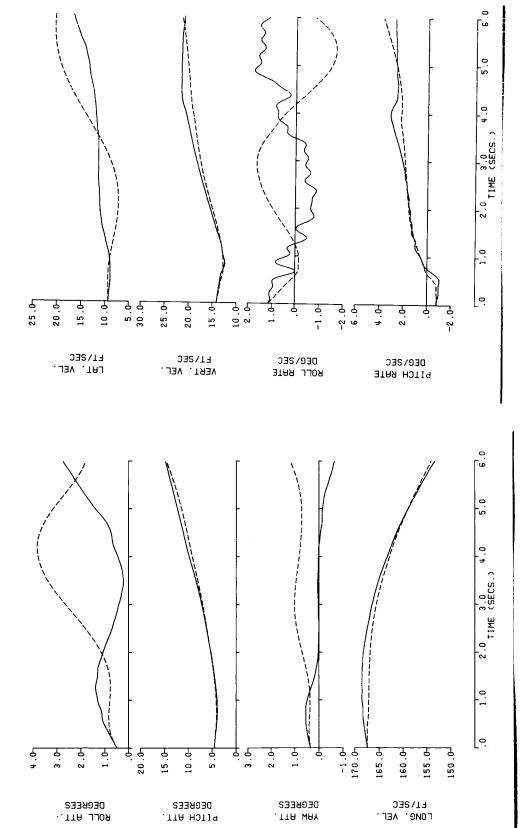
2.0 3.0 TIME (SECS.)

1.0

0

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 4)

Kalman Filtered Flight Data ---- Max. Likelihood Derivative Model (Method 5)



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 1). , \$4 Figure

----- Kalman Filtered Flight Data

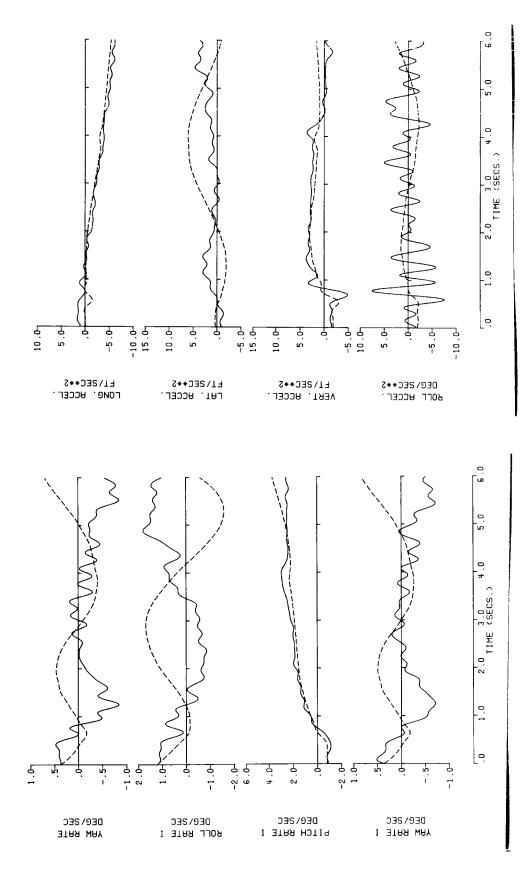
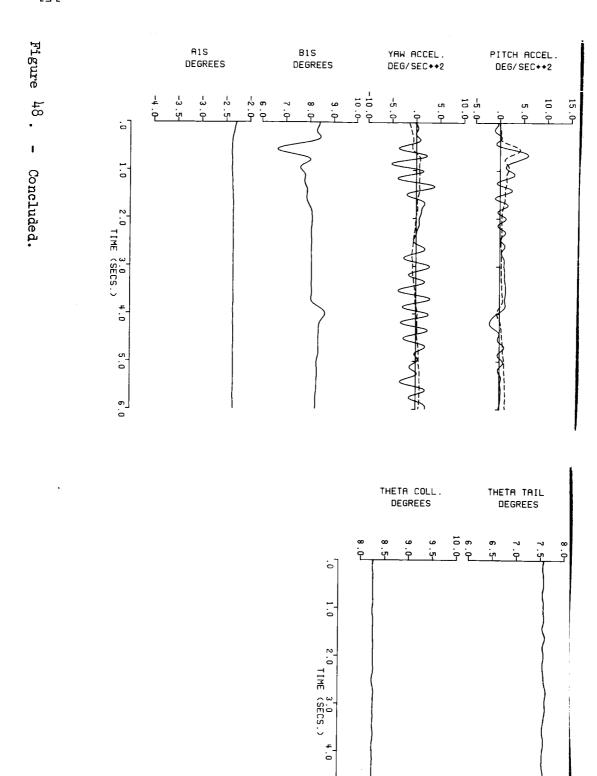


Figure 48. - Continued.

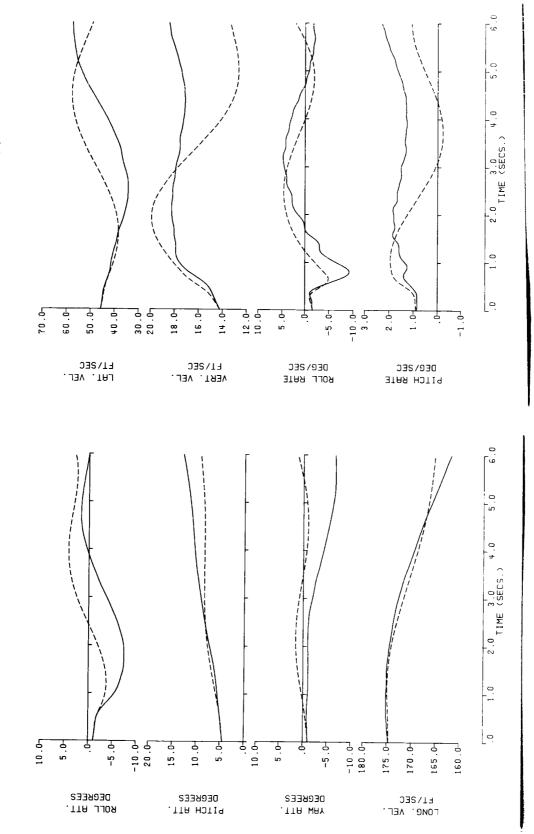


5.0

6.0

------ Kalman Filtered Flight Data

----- Max. Likelihood Derivative Model (Method 5) Kalman Filtered Flight Data



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 2). Figure 49

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

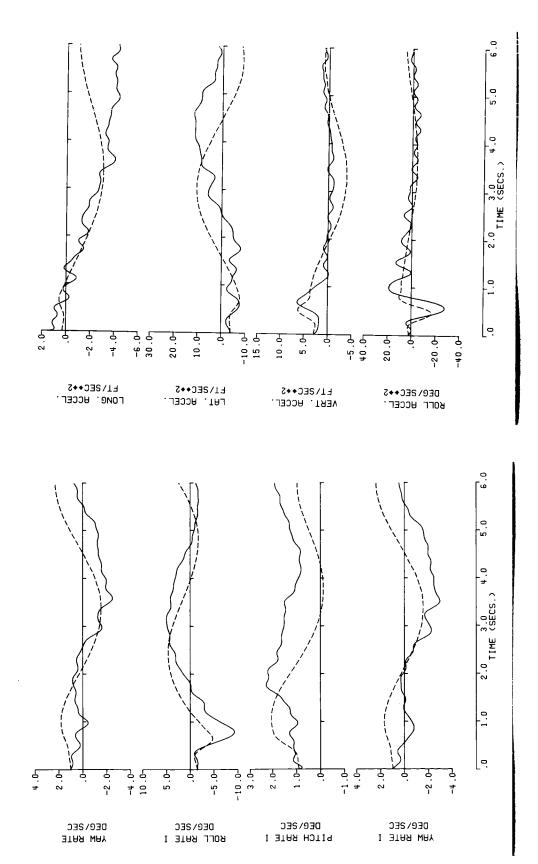


Figure 49. - Continued.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

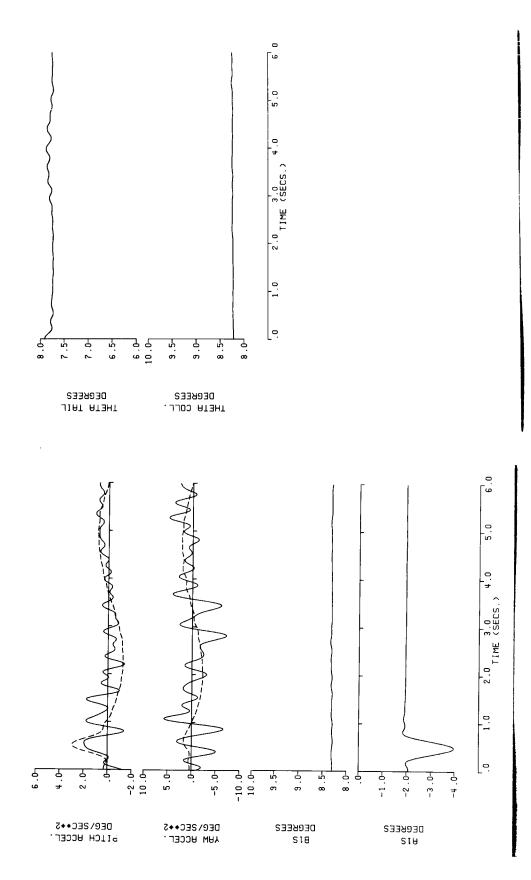


Figure 49. - Concluded.

0. [9 5.0 2.0 3.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 5) 1.0Kalman Filtered Flight Data 0. 20.05 10.P -20.0⁻30.0⁻ 25.0H 20.0F 15.0-10.01 5.0--5. P. الم، 15_ 20.05 15.0 10.0 9 -10.0 -10.0 מסרר מחדב סב6/SEC LAT. VEL. FT/SEC VERT. VEL. FT/SEC PITCH RATE DEG/SEC Г<u>9</u> 5.0 0. 2.0 3.0 TIME (SECS.) 1.0 6 10.01 -20.0H -30.0⁻ 20.0⁻ 5.0 -10.01 15.0H 5.P 10.01 ₹ -5.0 -10.0 -15.0 165.0م 160.0 155.0-150.0 145.0 ROLL ATT. DEGREES PITCH ATT. DEGREES YAW ATT. DEGREES LONG. VEL. FT/SEC

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 3). ı . 20 Figure

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

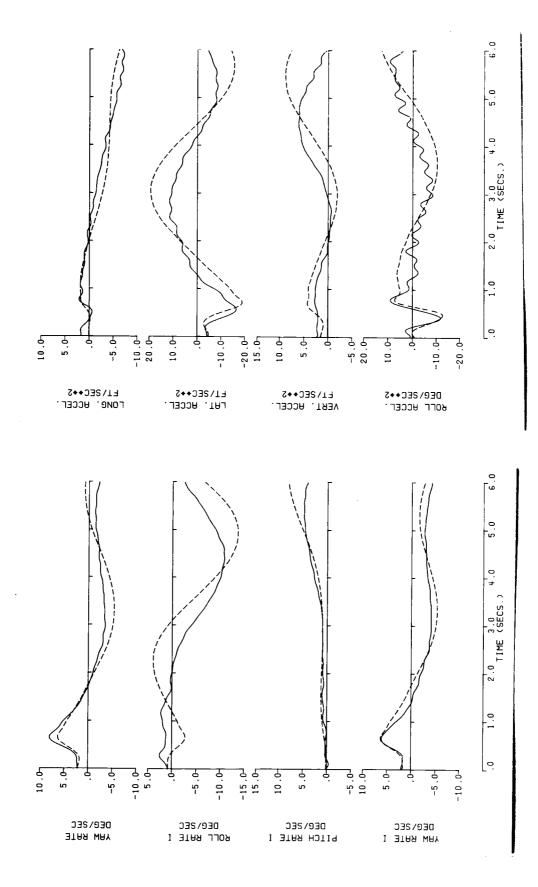


Figure 50. - Continued.

[9 |-2.0 3.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 5) 1.0 Kalman Filtered Flight Data 0. 2.01 10.01 8.0 THETA TAIL S33R530 THETA COLL. DEGREES و. 9 5.0 0. 2.0 3.0 TIME (SECS.) 1.0 [-. 6.0-<u>→</u> -2 .0⁻ 60 .0³ 20.05 8 . 7.0-6.0⁻ ±0.0+ -20.02-6.5 급. -2.5 PITCH ACCEL. DEG/SEC++2 DEG/SEC++5 DECKEES UIS DEGREES SIB

Figure 50. - Concluded.

0. 9 0 . ما 0. 2.0 3.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 5) 1.0 Kalman Filtered Flight Data 0 -10.01-30.07 5.P -5.P 9 25.0 20.05 10 . 01 15 . 0-15.0 10.0H -5.0-2.0 ₹ P LAT. VEL. FT/SEC VERT. VEL. FT/SEC BEG/SEC PIICH RATE DEG/SEC 6.0 5.0 0. 2'.0 3'.0 TIME (SECS.) 1.0 ا م 6.9 م -2.0⁻ 20.0⁻ 2. P <u>P</u> 2.P 165.07 160.0-15.0-10.01 9. Б. 9 155.0-150.04 145.07 DEGREES DEGREES DECKEES LONG. VEL. FT/SEC ROLL ATT. .IIA HJIIª .TTA WAY

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 4). ı 51. Figure

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

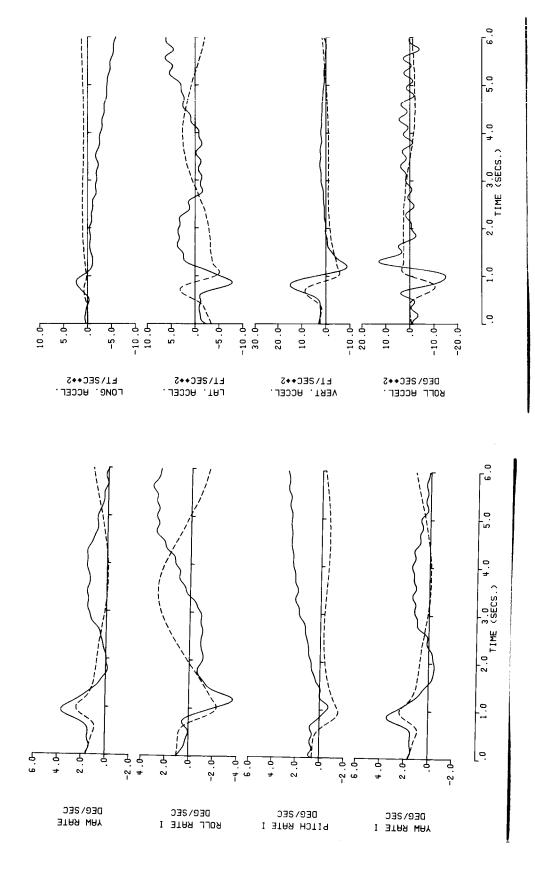


Figure 51. - Continued.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

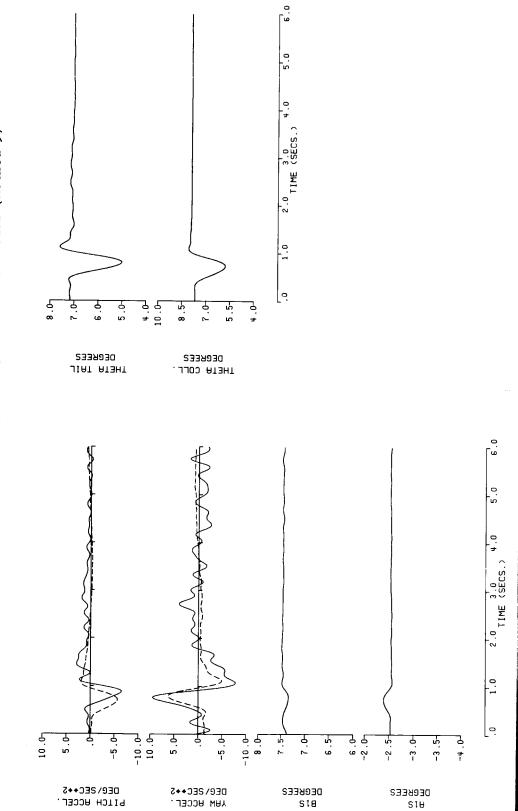


Figure 51. - Concluded.

0. [9 5.0 2.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 5) 1.0 Kalman Filtered Flight Data <u>|</u> 0. 80.09 60.01 20.05 15.0-±0.0+ 20.0-10.04 5.0 10.01 -5.0-5.0 ال- 10.00 10.01 5.0--10.01 LAT, VEL. FT/SEC VERT. VEL. FT/SEC BEG/SEC PITCH RATE DEG/SEC 0 ď. 0. 2.0 3.0 TIME (SECS.) 6 5.07 -15.0⁻ -6.002 200.09 -10.01 եր. ըլ-ը. 2. Դ -2.0<u>-</u> 180.0 170.04 5.9 -5.0-190.04 ġ لم. 160 ROLL ATT. DEGREES PITCH ATT. DEGREES YAW ATT. DEGREES LONG. VEL. FT/SEC

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 5). ı 52. Fi gure

------ Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

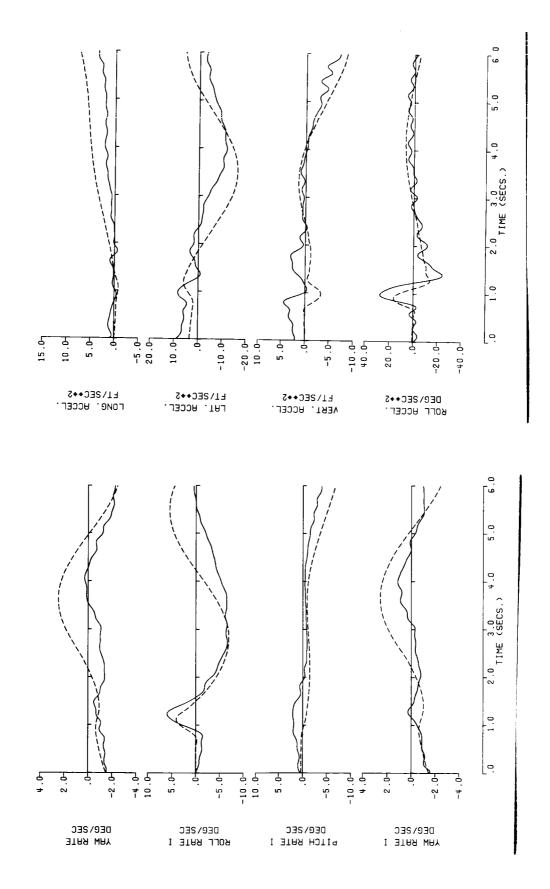


Figure 52. - Continued.

------ Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

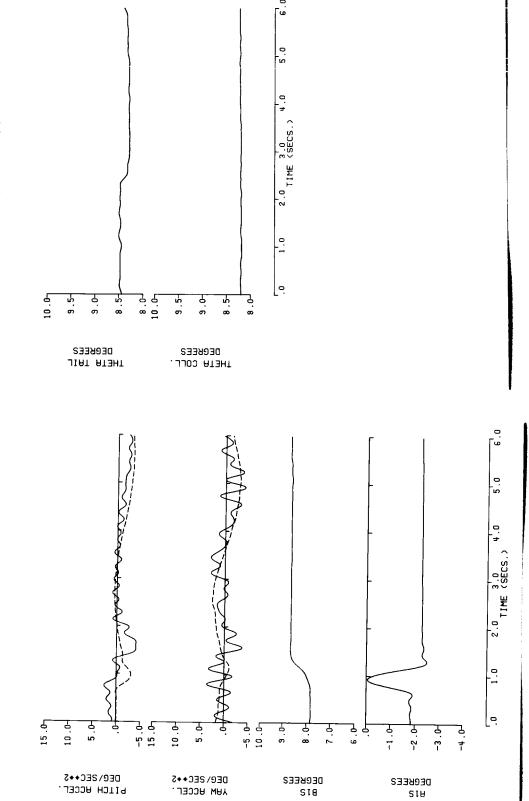
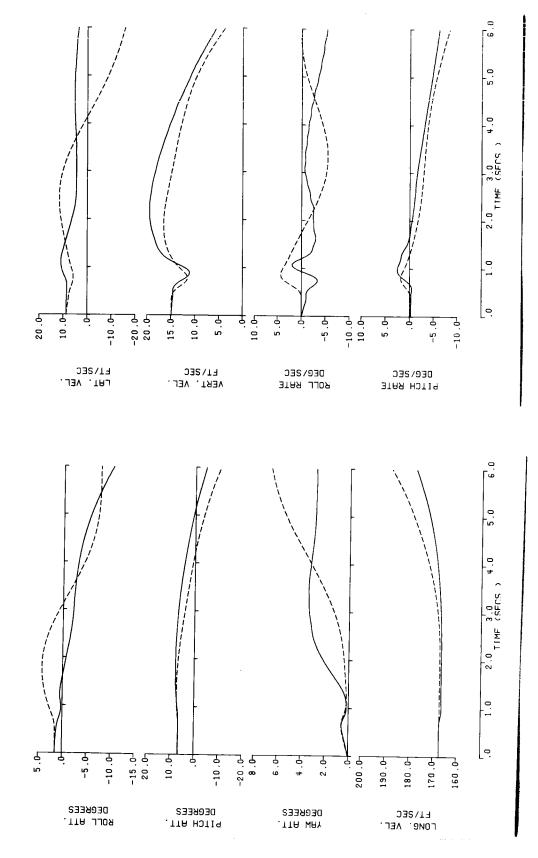


Figure 52. - Concluded.

----- Kalman Filtered Flight Data



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 6). 53 Figure

------ Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

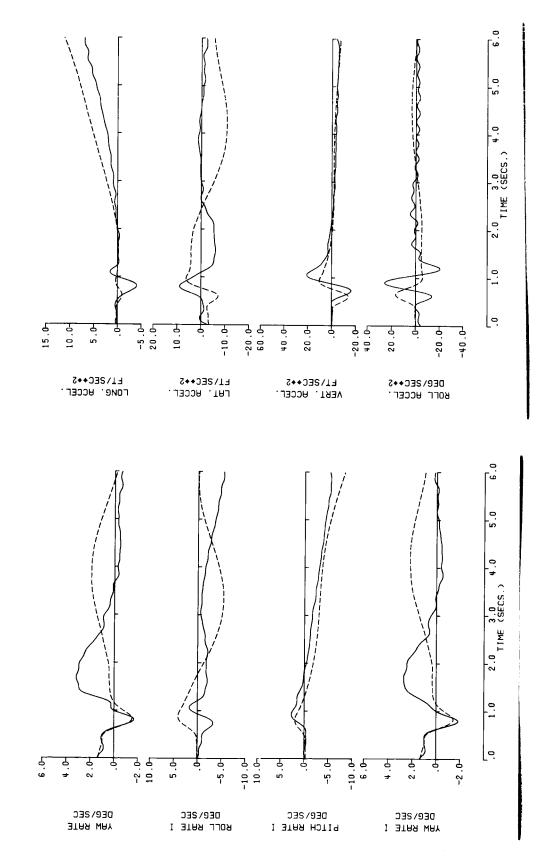


Figure 53. - Continued.

------ Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 5)

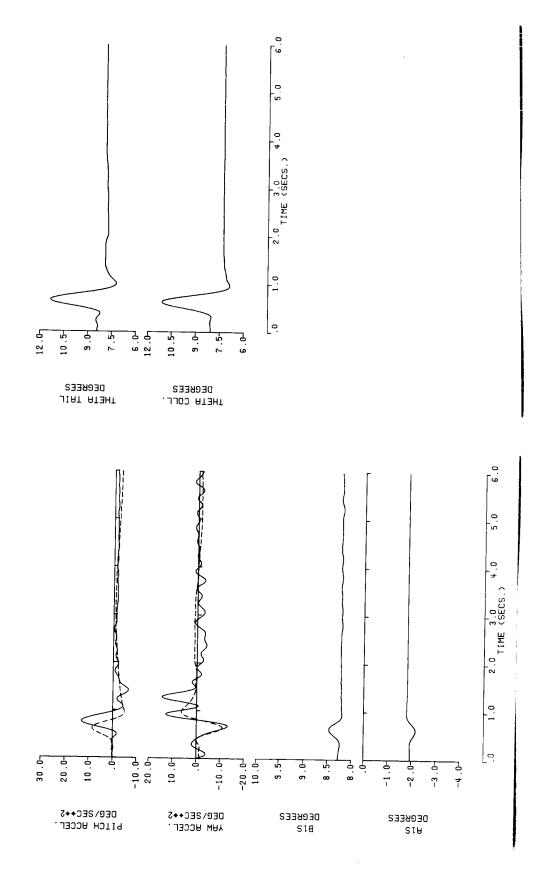


Figure 53. - Concluded.

6.0 5.0 Max. Likelihood Derivative Model (Method 6) . . 2'.0 3'.0 TIME (SECS.) 0. 30.0F 구.01 30.05 25.0-20.0H 10.01 15.0H 2. P. **→** 2 9 LAT. VEL. FT/SEC VERT. VEL. FT/SEC BEG/SEC DEG/SEC PITCH RATE DEG/SEC و. 9 5.0 0 2'.0 3'.0 TIME (SECS.) 1.0 0 5 T 4.5 10.0 -5.0⁻ 10.04 5. 1 -1.0⁻ ᅙ 160.0-155.0-150.07 165.0-DEGREES PITCH ATT. DEGREES LONG. VEL. FT/SEC DECKEES .סבר פוד. .TIA WAY

Kalman Filtered Flight Data

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 1). ŧ 54. Figure

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 6)

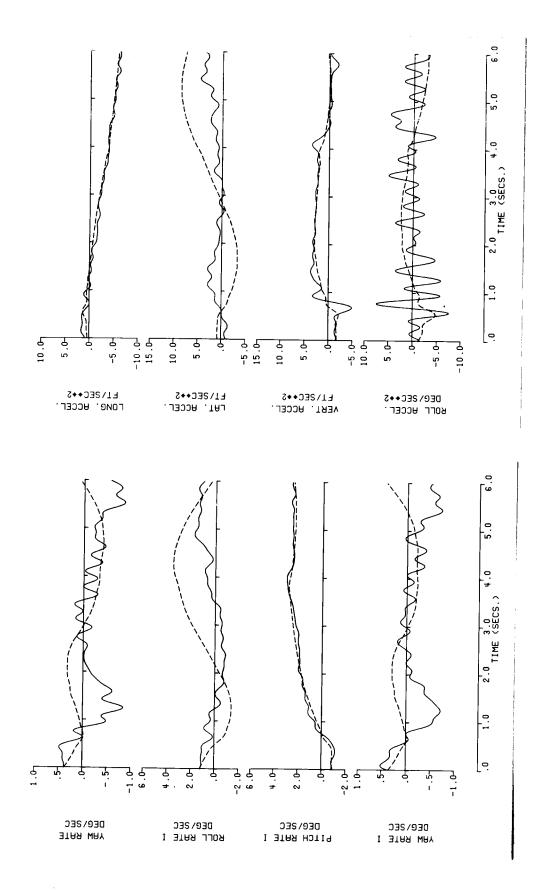


Figure 54. - Continued.

5,0 Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 0. 6.01 9.5 8 .5 THETA TAIL SEGREES THETA COLL. DEGREES 0 2'.0 3'.0 TIME (SECS.) 1.0 [0 15.9 10.01 -10 . 01 – 10 . 01 -5.01 10.01 9.0 -2.0д. 9 PITCH ACCEL. DEG/SEC++2 DEC\ZEC++5 DEGKEES B12 DECKEES UIS

Figure 54. - Concluded.

0.9 0. Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data .0 6 50.0 60.09 ₽. ₽. 30 .05 22 .0₇ 20.05 16.0-18.0 P # 01 9. 01 -10.01ë. P <u>+</u> Ը 2 9 LAT. VEL. FT/SEC VERT. VEL. FT/SEC ROLL RATE PITCH RATE DEG/SEC 5.0 2.0 3.0 TIME (SECS.) 1.0 [0. 10.91 لى 10 ـ 20 . 02 ة ع د 10.01 5. P. لم. 10.⁻ 180.04 5.0 لس. 160 170.0 165.0 ROLL ATT. DEGREES PITCH ATT. DEGREES YAW ATT. DEGREES LONG. VEL.

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 2). ı 55. Figure

5.0 Kalman Filtered Flight Data Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) [--2.0-Ţ. 30.0 10.08 20.04 10.0 ل-10.01 ر-15.0 10.0-5.0--5.0-20.04 -40.0 <u>.</u> FI/SEC++2 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 DEG/SEC++5 و. 9 5.0 2'.0 3'.0 TIME (SECS.) 1.0 6 2.0 4 5 9 - 6 -2.0-VAW RATE BEG/SEC BOFF BULE I PITCH RATE I DEG/SEC YAW RATE [

Figure 55. - Continued.

Figure 55. - Concluded.

5.0 Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data ļ۰. 10.01 -10.0H لى. 20 -30.05 25.0-20.04 15.0H 5 2.0 2.0 5. P 5.0 ال-0.01 ₽. 20.07 90LL RATE DEG/SEC PITCH RATE LAT. VEL. FT/SEC VERT, VEL. FT/SEC و. 9 5.0 0 ± 2.0 3.0 TIME (SECS.) 1.0 [0. ال 10.01 -10.01 -20.05 لى. 30 20.05 15.0 ٦. 4. °. 10.01 لم. 200 165.01 10.01 -10.01 150.04 145.0-160.0 155.0-ROLL ATT. DEGREES YAW ATT. DEGREES DEGREES LONG, VEL. FT/SEC тте нэтга

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 3) 1 <u>5</u>6 Figure

------ Kalman Filtered Flight Data

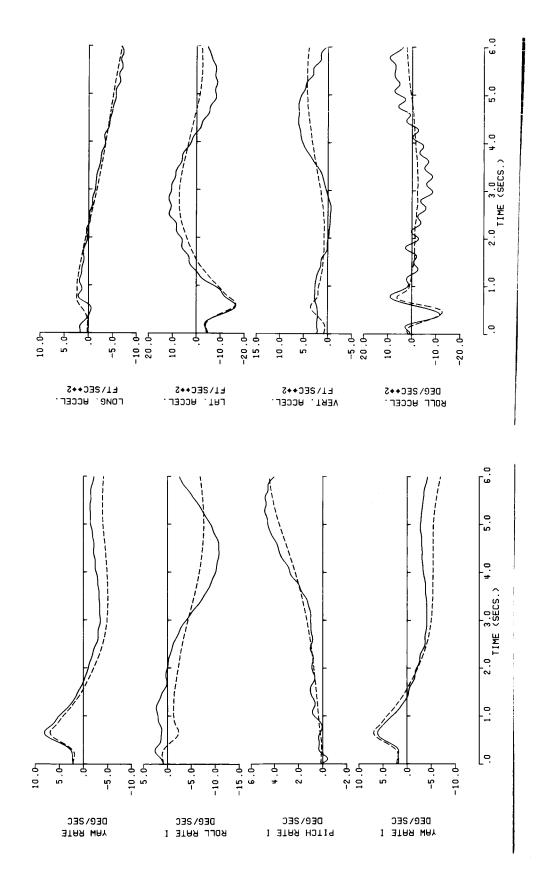


Figure 56. - Continued.

Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data 1.0 6 2.07 11AT AT3HT 23398330 тнетн согг. Обекееs 6.0 5.0 . • 2.0 3.0 TIME (SECS.) 1.0 6 4 2.0-9. -2.0⁻ -0.03 ₽. 01 20.05 -20.05--0.8 6.0⁻ ٦. † PITCH ACCEL. DEG/SEC++2 DEG/SEC++5 DEGKEES U12 DEGKEES BIS

Figure 56 - Concluded.

5.0 ----- Max. Likelihood Derivative Model (Method 6) . --2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data [0. 10.0 لم. 20. 30.05 ġ 25.0 10.01 15.01 20.07 15.0 LAT. VEL. FT/SEC VERT. VEL. FT/SEC 0E6/SEC PIICH RATE DEG/SEC .0 9 5.0 O. 2'.0 3'.0 TIME (SECS.) 1.0 [0. -5.0⁻¹ 10.0 2.9 170.04 150.0 140.0+1 5.0 15.0 10.0− 5.0 6.0-<u>→</u> 160.0 LONG. VEL. ROLL ATT. DEGREES PITCH ATT. DEGREES DEGKEER .TTA WAY

Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 4). ı 57. Figure

5.0 Kalman Filtered Flight Data Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) [e -10 .01-20 .05 10.01 ال-0.01 20.03 P. 01 ال-20.09 -10.01-10.01 20.04 -10.모 5. P VERT, ACCEL. FT/SEC++2 DEG/SEC++5 BOFF UCCEF: LONG. ACCEL. LAT. ACCEL. FT/SEC++2 5.0 0. 2'.0 3'.0 TIME (SECS.) -1 [0. -2.0-15.0-10.0I PITCH RATE I DEG/SEC DEG/SEC YAW RATE DEG/SEC DEG/SEC מסרר מטוב ו

Figure 57. - Continued.

----- Kalman Filtered Flight Data

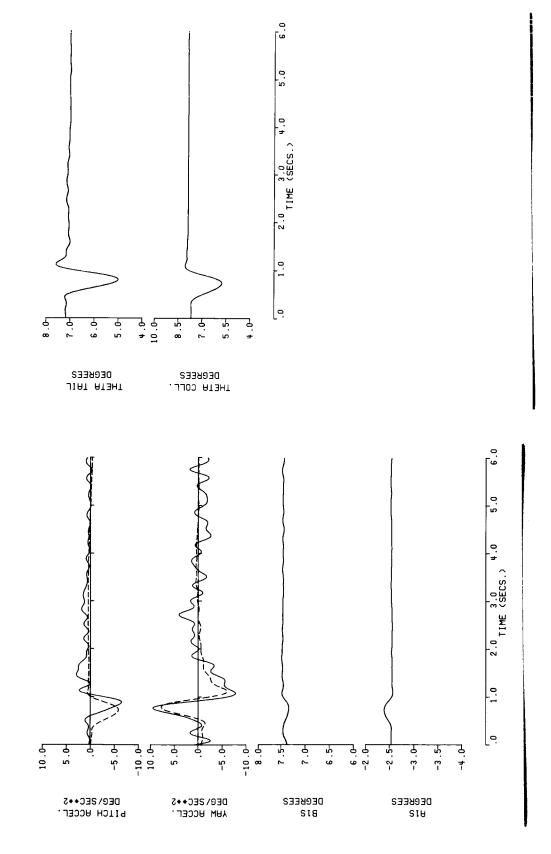
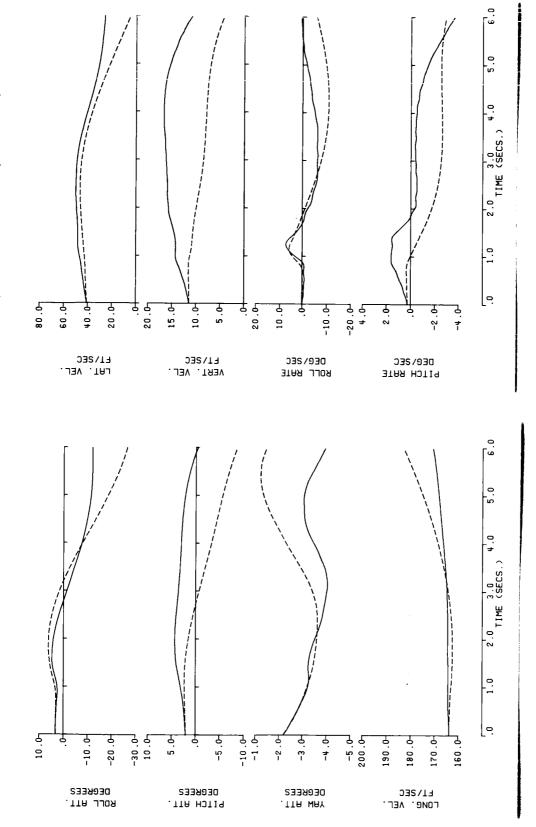


Figure 57. - Concluded.

----- Kalman Filtered Flight Data



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 5). ı . 28 Figure

------ Kalman Filtered Flight Data

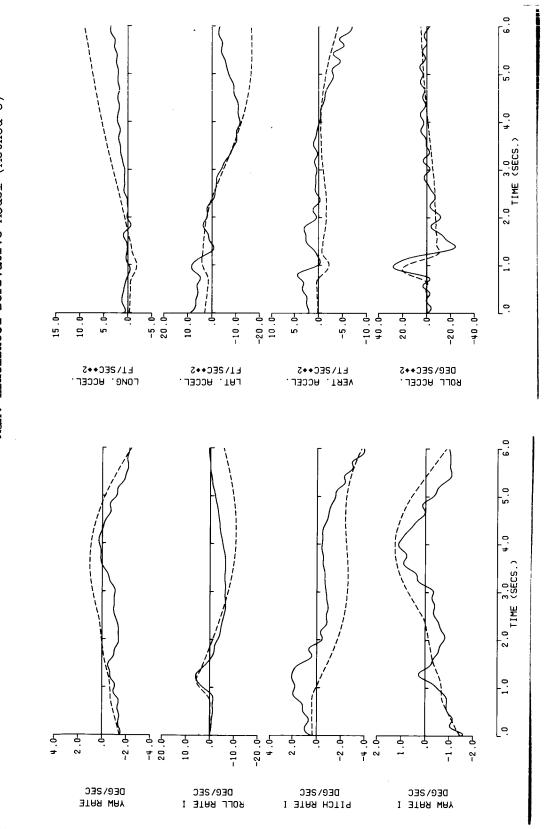


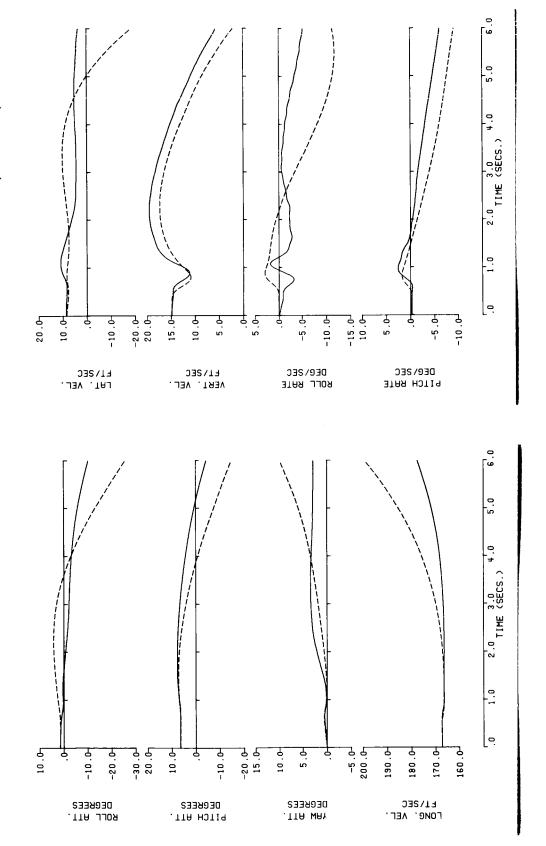
Figure 58. - Continued.

6.0 Kalman Filtered Flight Data Max. Likelihood Derivative Model (Method 6) 2'.0 3'.0 TIME (SECS.) -1 6 8.01 10.01 THETA TAIL DEGREES тнетА СОLL. DEGREES Ŋ 2.0 3.0 TIME (SECS.) 1.0 <u>-</u> 15.0م 10.01 -5.0-15.0-10.01 -5.01 10.09 **∞** 7.0-ان. م -1.0 -2.0<u>-</u> ٦. † PITCH ACCEL.

DEG/SEC++2 DEG/SEC++5 DECKEES B12 DEGKEES U18

Figure 58. - Concluded.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 6)



Time History Comparison of Identified Derivative Model Against CH-53A Flight Data (100 knots, Maneuver 6). ı 59 Figure

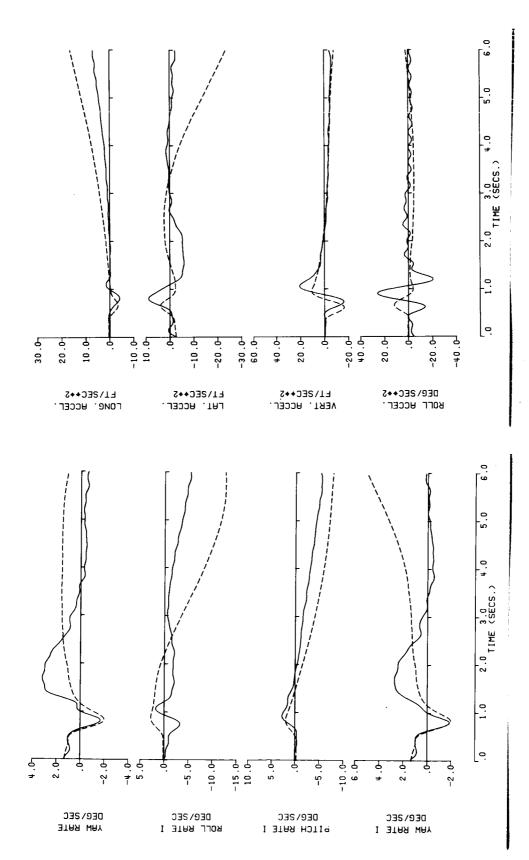


Figure 59. - Continued.

----- Kalman Filtered Flight Data ----- Max. Likelihood Derivative Model (Method 6)

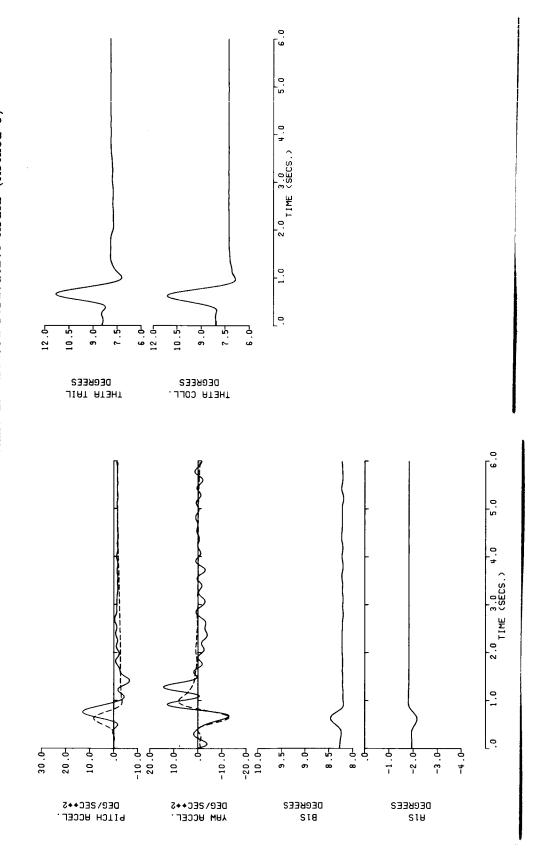
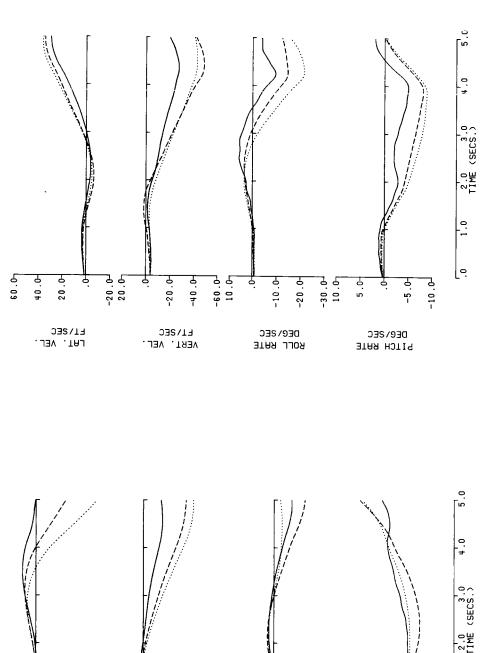


Figure 59. - Concluded.

Least Square Derivative Model (Method 3)
Max. Likelihood Derivative Model (Method 10) Kalman Filtered Flight Data



2'.0 3'.0 TIME (SECS.) .. 0. 0. 70.01 -10.01-280.07 -10.01 -20.01 -30.05-10.01 -20.0 -30.06-10.01 5.P -5.0F 275.0 270.04 265.0⊢ 260.04 ġ -10.0 ġ ROLL ATT. DEGREES PITCH ATT. DEGREES LONG, VEL. FT/SEC **DEGREES** .TIA WAY

Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (150 knots, Maneuver 1). ı 9 Figure

Figure 60. - Continued.

5.0 . -Max. LIkelihood Derivative Model (Method 10) 2.0 3.0 TIME (SECS.) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) 1.0 <u>|</u> 0. 15.07 10.0 5.0 -5.0-60.03 40.04 20.0--20.05--0.04 20.0H -20.0H L0.0+ 20.04 -20.0--40.01-L1\2EC+♦5 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. BEG/SEC++5 гоие: ыссег:

2'.0 3'.0 TIME (SECS.) [-2.9 -2.0 <u>구</u> -6.01 -10.01 -20.04 10.01 -10.01-2.07 -30.08-5.0 -5.0--2.0-Ÿ ROLL RATE I PITCH RATE I DEG/SEC DEC/2EC DEG/SEC YAW RATE

2'0 3'0 TIME (SECS.) ြ 12.0-10 . 01 16 . 0 ₽. ¥1 13.0-12.0 15.P 13.0-THETA COLL. DEGREES THETA TAIL SEGREES 5.0 0. 2.0 3.0 TIME (SECS.) [e -10.0⁻ 15.0₋ -5.0-14.0-12.0 10.01 ال 19.9 -2.0-PITCH ACCEL. DEG/SEC++5 DECKEES BIS DEGKEES U18

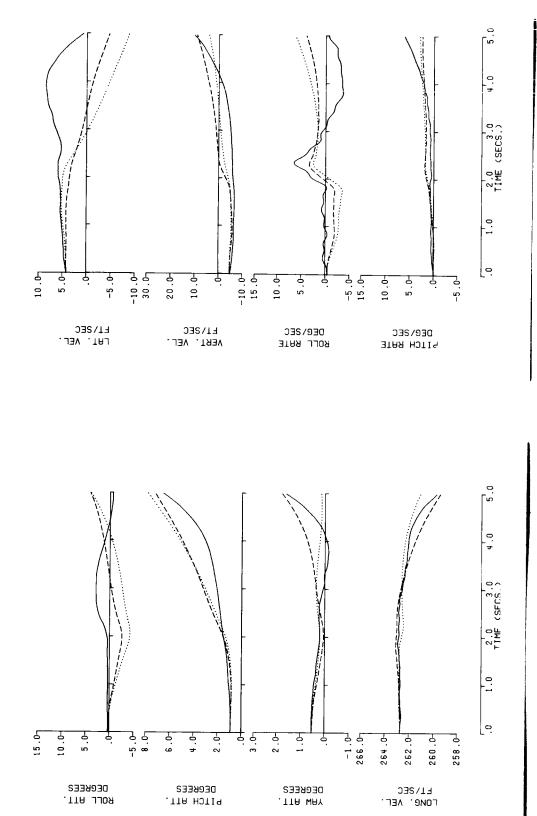
· •

Max. Likelihood Derivative Model (Method 10)

Kalman Filtered Flight Data Least Square Derivative Model (Method 3)

Figure 60. - Concluded.

------ Kalman Filtered Flight Data Least Square Derivative Model (Method 3) ----- Max. Likelihood Derivative Model (Method 10)



Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (150 knots, Maneuver 2). ı 61. Figure

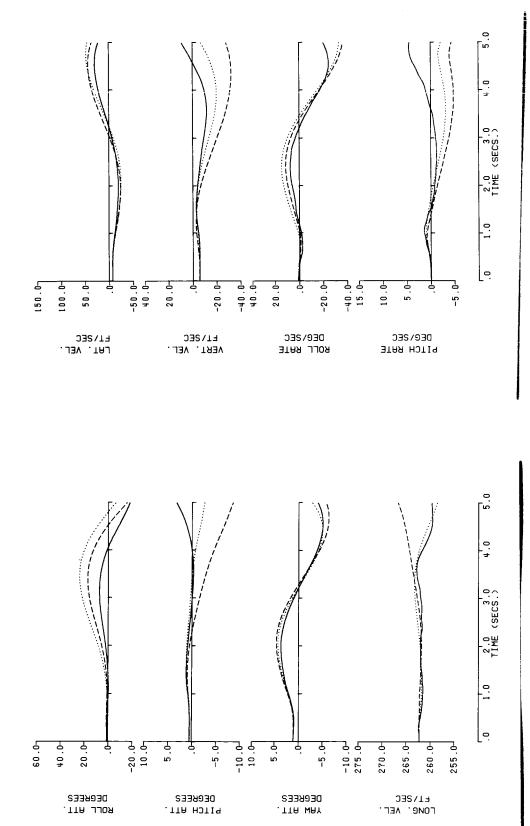
0. Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 10) 2.0 3.0 TIME (SECS.) [o. . 6. Q. J. 0--10.01 20.05 10.0--15.0⁻ -10.09 -10.01-60.03 ₽. 01 20.04 -20.02-LONG. ACCEL. FT/SEC++2 LAT. ACCEL. FI/SEC++2 VERT, ACCEL. FT/SEC++2 BEG/SEC++2 0 2.0 3.0 TIME (SECS.) 0. <u>1</u> -1.0¹ 9 6.0 2 . . Р. ل-2.0 2.0 DEG/SEC PITCH RATE I DEG/SEC DER/SEC DEC/SEC YAW RATE אסרר אחדE ז YAW RATE I

Figure 61. - Continued.

Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 10) 2.0 3.0 TIME (SECS.) 0 14.07 13.0 12.5-12.01 16.01 15.5-15.0-1‡.P 13.5-14.5 THETA TAIL SEGREES THETA COLL. DEGREES 5.0 2.0 3.0 TIME (SECS.) 1,0 0. 10.0-5.0 ال-5.0⁴ 12.0 10.01 -1.0--2.0-PITCH ACCEL. DEG/SEC++2 DECKEES BIS DEG/SEC++5 DEGKEES UIS

Figure 61 - Concluded.

------ Kalman Filtered Flight Data
..... Least Square Derivative Model (Method 3)
----- Max. Likelihood Derivative Model (Method 10)



Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (150 knots, Maneuver 3). t 62 Figure

Ľď. · 0 ----- Kalman Filtered Flight Data Least Square Derivative Model (Method 3) ----- Max. Likelihood Derivative Model (Method 10) 2.0 3.0 TIME (SECS.) 1.0 0. ٦0 .01 لل. 10 ـ 150.07 50.0 -50 .03--0.03 ل-20.01 بو.0+ 100.0-40.0+ 20.05 20.04 ال-0.0*− -20.04 LAT. ACCEL. FT/SEC++2 VERT. ACCEL. FT/SEC++2 BEG/SEC++5 L1\SEC++5 רסאפ. אככבר. 5.0 2'.0 3'.0 TIME (SECS.) [o. 5.0 -10.01 ال 10.0 -10.0⁻ 20.0H -20.0--+0.0+ 15.0+ 10.0-5.0 -5.0⁻¹ 5.0 PITCH RATE I DEG/SEC DEG/SEC DEG/SEC DE@\ SEC YAW RATE ROLL RATE I

Figure 62. - Continued.

Least Square Derivative Model (Method 3)
Max. Likelihood Derivative Model (Method 10) 0. 16.09 ₹. 13.0 10.0¹ 16.0¹ 15.5-15.0 ٦٠.۴ 14.5 THETA TAIL SEGREES THETA COLL. DEGREES

10.0-

PITCH ACCEL.

-5.0⁻

20.0-10.0-

DEG/SEC++5

-10.01-14.0-

13.0-12.0-

DEGREES B18

10.01 -2.0-

-2.5-

DEGKEES U12

5.0

2.0 3.0 TIME (SECS.)

<u>.</u>.

Concluded. 62 Figure

5.0

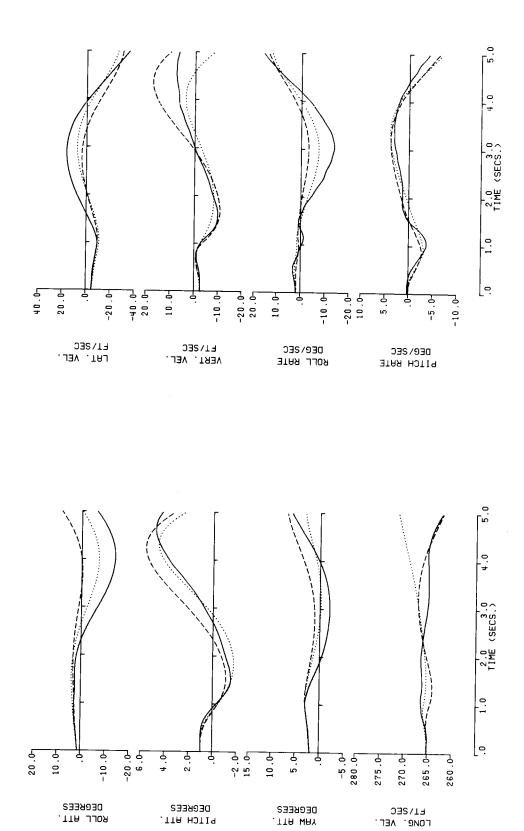
. --

2.0 3.0 TIME (SECS.)

.. ..

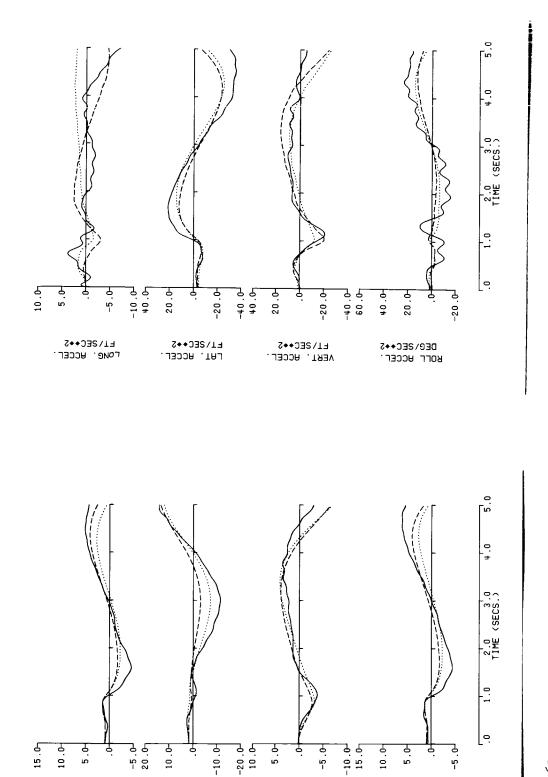
<u>|</u> 0.

------ Kalman Filtered Flight Data
..... Least Square Derivative Model (Method 3)
----- Max. Likelihood Derivative Model (Method 10)



Time History Comparison of Identified Derivative Models Against CH-53A Flight Data (150 knots, Maneuver 4). 63 Figure

----- Kalman Filtered Flight Data
..... Least Square Derivative Model (Method 3)
----- Max. Likelihood Derivative Model (Method 10)



ROLL RATE 1

DEG/SEC

YAW RATE

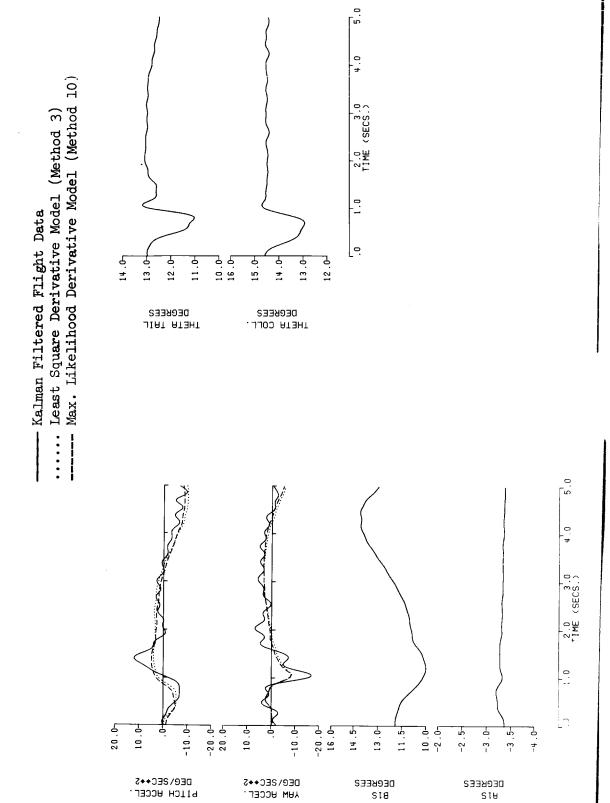
Figure 63. - Continued.

DEG/SEC

DEC/SEC

PITCH RATE I

Figure 63. - Concluded.



0. 9 5.0 -] 2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data [e. 30.07 20.05 10.01 -10.01 10.01 -10.0-20.04 -20.05لى. 30 -+0.0+ -20.0-_0.0#− 10.01 -5.0-5.0 -10.01LAT. VEL. FT/SEC VERT, VEL. FT/SEC DEG/SEC BOLL RATE PIICH RATE DEG/SEC 9.0 5.0 0. 2.0 3'.0 TIME (SECS.) 0 30.0520.05 10.04 -10.01-5.0-Ω. -5.0--15.0-335.0--10.01 330.04 325.0-320.04 315.0-1 74.0-47 72.04 70.07 68.0-66.04 DEGREES DEGKEES YAW ATT. DEGREES LONG. VEL. ROLL ATT. PITCH AII.

Time History Comparison of Identified Derivative Models Against CH-54B Flight Data (45 knots, Maneuver 1). Figure 64

5,0 2.0 3.0 TIME (SECS.) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 0. [e. -2.0-30.0-10.0 -10.0⁻ 5.0-20.0 -5.0--10.01 -15.0-150.0-50.0-100.00 LAT. ACCEL. FT/SEC++2 FI/SEC++2 VERT. ACCEL. FT/SEC++2 BEG/SEC++5 0. [9 5.0 2.0 3.0 TIME (SECS.) 1.0 [o. 15.07 10.01 10.0-5.0--5.01 20.0--20.0--10.01 -15.0 10.0-5.0--5.0-5.0 YAW RATE DEG/SEC DEG/SEC BOLL RATE I PITCH RATE I DEG/SEC DE@\ SEC YAW RATE I

Figure 64, - Continued.

. [9 5.0 2'.0 3'.0 TIME (SECS.) ----- Kalman Filtered Flight Data ----- Least Square Derivative Model (Method 3) ----- Max. Likelihood Derivative Model (Method 9) ... 6 و. 6 5.P Э. Р 2.9-1.9--2.5--3.P -3.5 ٦. 1. THETA TAIL SEGREES THETA COLL. DEGREES 5.0 . • 2.0 3.0 TIME (SECS.) 1.0 0 10.01 20.02 ال- 10.0 15.0 10.01 م -5.0 6.0 م. 9. 3.0 2.9 2.9 7. 고. PITCH ACCEL.

DEG/SEC++2 DEG/SEC++5 DEGKEES B18 DECKEES U12

Figure 64. - Concluded.

5.0 0. 2'.0 3'.0 TIME (SECS.) Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) MANAGE STATE 1.0 Kalman Filtered Flight Data 0 P. 01 40.04 20.04 -20.05 년. 0년 10. 01 50.0H -100.0d 150.09 30.0E 20.01 -50.01 100.00 50.0 -50.04 LAT. VEL. FT/SEC VERT. VEL. FT/SEC PITCH RATE DEG/SEC DEC/SEC ROLL RATE 0.9 5.0 • • • • • • 0. 2.0 3.0 TIME (SECS.) ļ 0. -150.0d -150.0d ال-20.09 о. Р. ₽.0 20.02 100.091 50.0 -50.0 -100.0d 110.0q P. 001 90.06 90.08 -100.0-ROLL ATT. DEGREES YAW ATT. DEGREES LONG, VEL. F1/SEC DECKEES

TITCH HIII

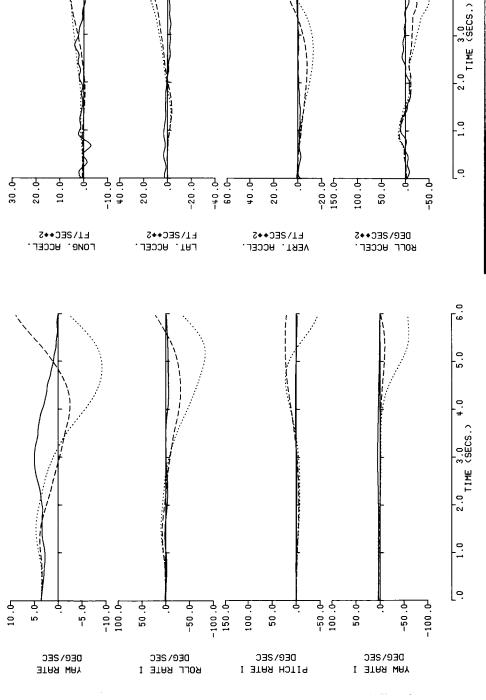
Time History Comparison of Identified Derivative Models Against CH-54B Flight Data (45 knots, Maneuver 2). ı 65. Figure

6. 6.0

1.0 ļ۰. -20 .0⁻ 150 .0₋ 50.0-BEG/SEC++5 - Continued. 0.1 50.0 FigureDEC/SEC YAW RATE I

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Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) Kalman Filtered Flight Data



0. [% 5.0 2'.0 3'.0 TIME (SECS.) Kalman Filtered Flight Data Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 0. ြ 5.P ار. 2 او. 3-THETA COLL. DEGREES DEGKEES JIAT ATBHT ا. 0. 5.0 2'.0 3'.0 TIME (SECS.) 1.0 6 ₽. 01 20.04 -20 .05 -20 .05 10.01 P.01 -10.0⁻ 5.0 20.0 <u>, ?</u> » 9 2.9 2.9 1. P. DEG/SEC++5 DEC/SEC++5 DEGREES DEGKEES PITCH ACCEL. SIB SIU

Figure 65. - Concluded.

. 9 5.0 0.4 2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) 1.0 Kalman Filtered Flight Data [e. 30.05 -10.01 10.01 -20.0-ل-0.06 ٦٠ 01 -10.01 -20.0--30.08-60.09 ±0.0+ 20.04 ك0.02-20.05 10.0T -10.0-PITCH RATE DEG/SEC LAT. VEL. FT/SEC VERT. VE FT/SEC BEG/SEC . ПЭМ 6.0 5.0 . -2'.0 3'.0 TIME (SECS.) 1.0 6 ÷0.0 20.0 350.07 P. 09 -20.05 ال-10.04 20.04 340.0-310.018 P.0.07 50.07 30.07 10. OI ال-10.01 330.0H 320.0H 65.P 55.0 LONG, VEL. FT/SEC OEGREES DEGREES DEGREES ROLL ATT. PITCH AII. .TIR WRY

Time History Comparison of Identified Derivative Models Against CH-54B Flight Data (45 knots, Maneuver 3). ı Figure 66.

Figure 66 - Continued.

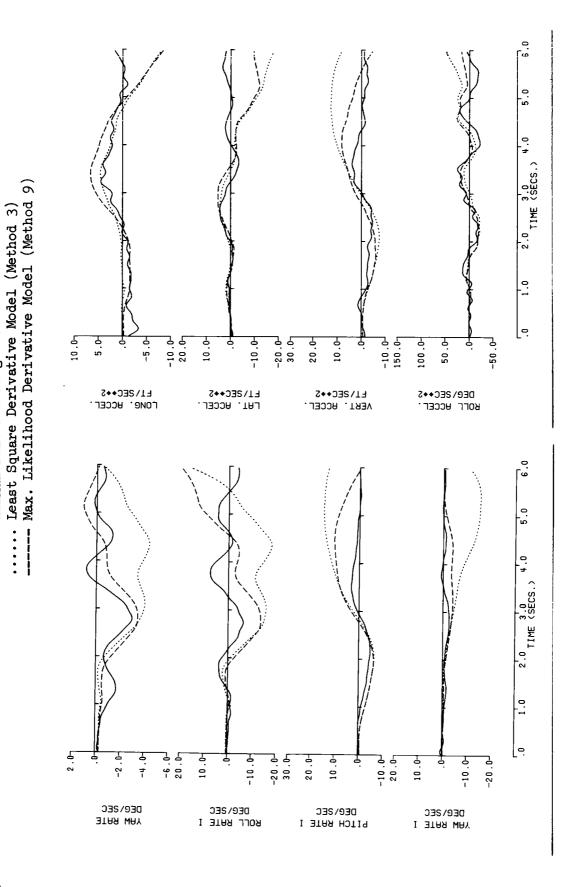
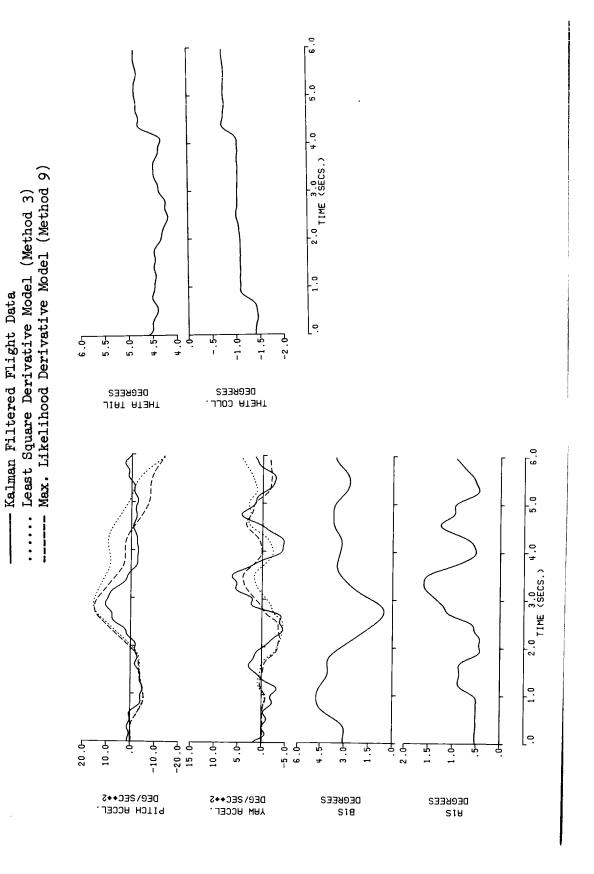


Figure 66. - Concluded.



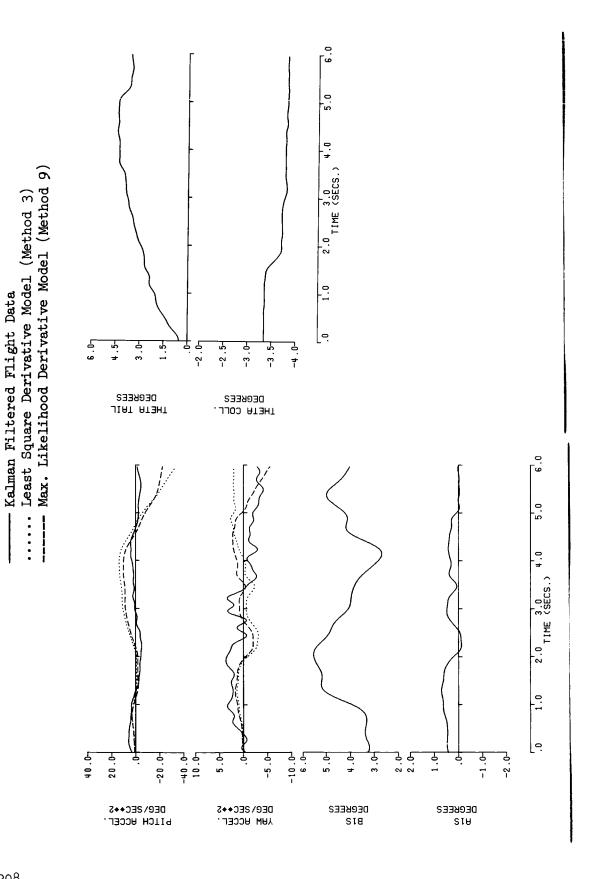
.0 5.0 .. + 2'.0 3'.0 TIME (SECS.) Max. Likelihood Derivative Model (Method 9) Least Square Derivative Model (Method 3) .0 Kalman Filtered Flight Data <u>|</u> 0. 20.0 -20.0--£0.0€ -20.0€ 10.0I -10.01 150.07 100.00 20.0Z 50.0 -50.02 30.09 20.0F 10.01 LAT. VEL. FT/SEC VERT. VEL. FT/SEC SOLL RATE PITCH RATE DEG/SEC .9 9.9 5.0 • • • • • • 2.0 3.0 +.0 TIME (SECS.) .. ĺΘ ر0.0 20.04 -20.0-년: 0.6 년: 0.0 ₽. P. 20.02 -20.05-360.09 340.0 320.0 300.P 280.0⁴ 65.0 P. 08 75.0 70.07 LONG. VEL. FT/SEC DEGREES DERKEES DEGREES ROLL ATT. TIA HOTI9 .TTA WAY

Time History Comparison of Identified Derivative Models Against CH-54B Flight Data (45 knots, Maneuver μ). ı Figure 67.

Least Square Derivative Model (Method 3) Max. Likelihood Derivative Model (Method 9) 1.0 ļ 0. 10.0 50.0--30.05 -30.08 20.04 -10.01-150.09 -10.0I--20.0--10.01 -15.01 -10.01 BEG/SEC++5 VERT. ACCEL FT/SEC++2 LONG. ACCEL LAT. ACCEL FT/SEC++2 5.0 0. + 2.0 3.0 TIME (SECS.) <u>.</u> 10.01 -50.02 20.0-10.01 20.05 15.9 10.0--5.0⁻ 100.04 50.0--10.0 5. P YAW RATE I ROLL RATE I PITCH RATE I DEG/SEC YAW RATE DEG/SEC

Figure 67. - Continued.

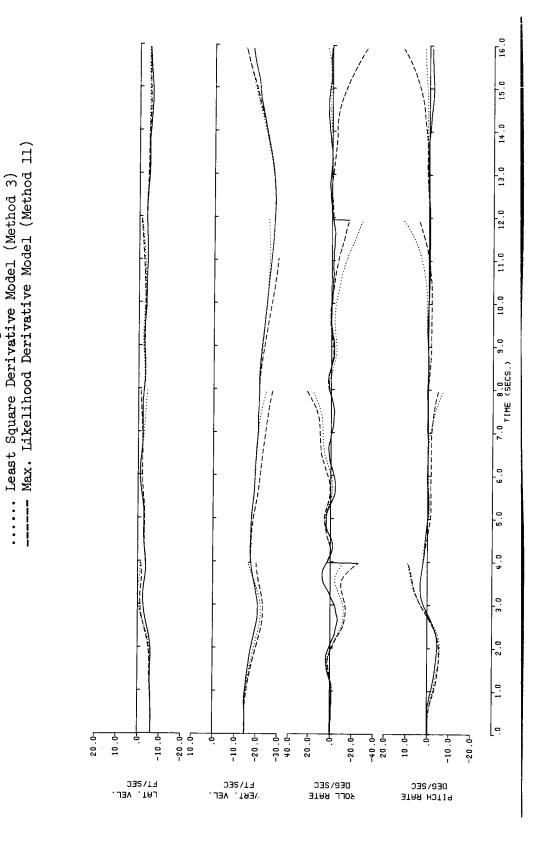
Figure 67. - Concluded.



16.0 15.0 14 .0 Least Square Derivative Model (Method 3)
Max. Likelihood Derivative Model (Method 11) 13.0 12.0 11.0 Kalman Filtered Flight Data 10,0 9.0 8.0 (SECS.) 7.0 TIME -0.9 • • • • • • • 5.0 <u>.</u> 3.0 5.0 .. <u>|</u> e 20.02 10.0 -20.05 -20.05 10.01 لم. 200 360 .09 300.04 80.09 50.0 L0.0* -10.01 330.0⊢ P. 09 70.07 345.0-ROLL ATT. DEGREES YAW ATT. DEGREES PITCH ATT. DEGREES LONG. VEL.

Time History Comparison of Identified Derivative Models Against CH-54B Flight Data (45 knots, 16 sec. Maneuver). 89 Figure

Figure 68. - Continued.



16.0 15.0 14.0 Max. Likelihood Derivative Model (Method 11) 13.0 Kalman Filtered Flight Data Least Square Derivative Model (Method 3) 12.0 11,0 10,0 7.0 8.0 TIME (SECS.) 9.0 2,0 1,0 0 10.01 5. P -10.0¹-20.05 -20.0-_40.04 _20.02 요. 01 -10.01 -20 .05--20 .01 ال0.01 YAW RATE DEG/SEC 90LL RATE I 056/5EC PITCH RATE I DEG/SEC 1 3184 WAYE 1 0E6/SEC

Figure 68. - Continued.

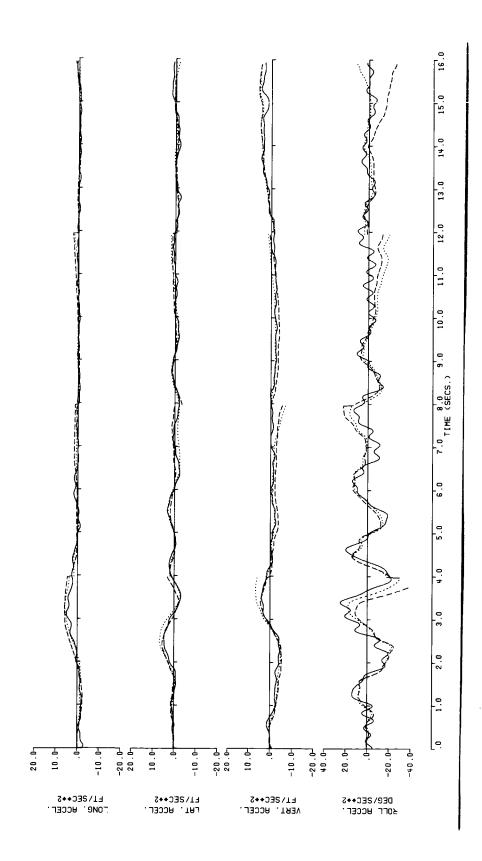


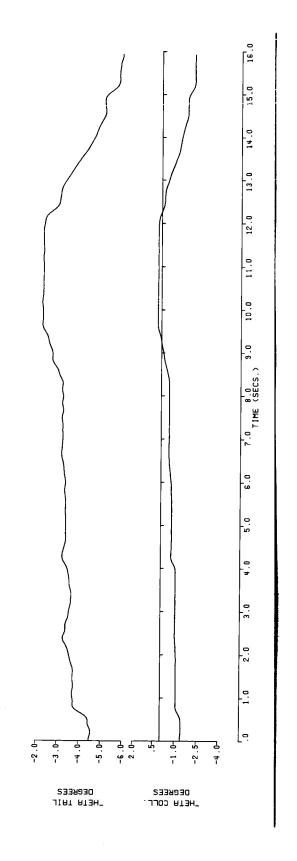
Figure 68. - Continued.

16.0 12 0. Least Square Derivative Model (Method 3)
Max. Likelihood Derivative Model (Method 11) 13,0 12.0 1.0 0.0 9.0 7.0 8.0 TIME (SECS.) 5.0 --3.0 2.0 1.0 20.09 P. 61 -10.日 10.01 <u>ځ</u> د DEG/SEC++2 DEG/SEC++5 DEGKEES 318 DECKEES U12

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Continued. 1 **.** Fi gure

Figure 68. - Concluded.



----- Kalman Filtered Flight Data Least Square Derivative Model (Method 3) ----- Max. Likelihood Derivative Model (Method 11)